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MONTHLY WEATHER REVIEW

JULY 1936

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UNITED STATES DEPARTMENT OF AGRICULTURE

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CORRECTIONS

Volume 64, April 1936, page 122: In column 2, third paragraph, 8th line, change "15 miles" to "15 meters"; page 128, in the legend to figure 6, change "300" to "274"; page 131, column 1, under equation 6, delete "P_s, that is,".

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MONTHLY WEATHER REVIEW

Editor, EDGAR W. WOOLARD

VOL. 64, No. 7
W. B. No. 1187

JULY 1936

CLOSED SEPTEMBER 3, 1936
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CHARLES FITZHUGH TALMAN, 1874–1936

Charles Fitzhugh Talman (Aug. 31, 1874, Detroit, Mich.–July 24, 1936, Washington, D. C.), meteorologist and writer, was the son of Robert Fitzhugh Talman, who was born at Rochester, N. Y., and Jessica (Mack) Talman, born near St. Claire, Mich. On his father's side he was descended from Dr. John Talman, one of the founders of Hudson, N. Y., whose son, John Thurston Talman, married Mary Eleanor Fitzhugh, daughter of Col. William Fitzhugh, one of the founders of Rochester, N. Y., and a grandson of the English emigrant, William Fitzhugh ("Fighting Billy") of Ravensworth, Va., who was noted for his integrity and legal ability. On his mother's side, an early ancestor was Col. Andrew Mack (born Mar. 9, 1780, at Windsor, Conn.), a colorful character in the early development of Cincinnati, Ohio, and Detroit, Mich. In 1829 Colonel Mack moved from Cincinnati to Detroit, having been appointed Collector of the Port by President Andrew Jackson. He was one of the original owners of the Detroit Free Press, served in the legislatures of both Ohio and Michigan, and was Mayor of Detroit during 1834–35.

Charles Fitzhugh Talman was educated in the Detroit public schools, Detroit High School (graduated June 1892) and Kalamazoo College, and by private tutors.

He was appointed Observer in the United States Weather Bureau on October 2, 1896, and stationed at Norfolk, Va. In 1898–99 he had charge of Weather Bureau stations in the West Indies and on the Caribbean coast of South America, being stationed at Colon, Colombia (now Canal Zone), August 19, 1898–June 6, 1899, and at Kingston, Jamaica, June 6, 1899–September 11, 1899. He was then recalled to the States and located for brief periods at Boston, Mass., Springfield, Ill., and Buffalo, N. Y., in the order given. On May 9, 1900, he was called to the Central Office of the Weather Bureau, Washington, D. C., where he was later appointed Assistant Librarian on December 11, 1907, and Librarian on July 1, 1908. On July 16, 1914, he was promoted to Professor of Meteorology, and continued in charge of the library. On September 1, 1935, he became Meteorologist by official title, and Meteorological Consultant by assignment of duties—a recognition of what, in fact, he had been for many years, and for which he was especially fitted by his wide acquaintance with the literature of the subject and his knowledge of many languages, including Greek and Latin.

The sixty-thousand-volume meteorological library of which Mr. Talman had charge is second to none of its kind, and was raised to this rank largely by his wise selections and persistent efforts. Not only is it a vast storehouse of potential knowledge but, with Talman to guide and assist, it was an inexhaustible fund of ready information. It was not necessary to tell him what particular book one wanted, but sufficient to ask what had been published on such and such a subject, for immediately all the literature bearing on it would be placed at one's disposal, and to all alike, high position or no position, with the same unfailing kindness and ever readiness to help. In his presence none could feel superior and none was made to feel inferior.

In figure he was trim and slightly tall; in dress neat and tasteful; and in movement rapid and sure, even during the last month of his life, when much of the time he was too ill to be at his office.

He contributed many articles to the New York Times, New York Herald Tribune, Nature Magazine, American Mercury, etc.; wrote for several reference books and for the Standard Dictionary (1910–11); and wrote the daily newspaper feature, "Why the Weather?", syndicated by Science Service—nearly 3,000 separate articles, from April 25, 1927. In addition to this immense amount of high-class journalistic work he also published two delightful books: "Meteorology, the Science of the Atmosphere" (Colliers, 1922), republished by Reynolds Publishing Co., N. Y., 1925, as "Our Weather"; and "The Realm of the Air" (Bobbs-Merrill, 1931). And all his writings, from articles for the daily press to books for the library, were both pleasing and safe—excellent in style and accurate in statement. The service he thus rendered the public, and the intelligent support he won for the science of the weather, are incalculably great. Fortunate it is that the good men do is not always buried with them.

Such was Talman's work, apart from the endless routine requirements of his position, and the supplying of information in response to daily inquiries from all sorts of people on all manner of subjects; and his hobby, meteorological lexicography, was even more exacting and, if possible, more valuable. To this encylcopedic meteorological dictionary he gave the most careful and persistent attention for many years, and accumulated for it a vast fund of information and references, all arranged in systematic alphabetical order. Those of us, and we are many, who have had occasion to consult the manuscript of this great dictionary, know how exceedingly helpful it is, and realize, too, that, so far as possible, it just must be completed and made available to all who may need it.

He was a member of the American Meteorological Society (councilor, 1921–22); the Geophysical Union; the District of Columbia Library Association, etc., and a fellow of the American Association for the Advancement of Science.

On November 16, 1909, he married Miss Grace Fletcher Edes of Washington, D. C., daughter of the late Lt. Comdr. B. L. Edes, U. S. N. Their children are Constance Elizabeth Marjorie (Nov. 27, 1910), who married (November 8, 1935) Señor Mario Rodriguez of the Chilean Diplomatic Service; and Benjamin Long Edes (Aug. 13, 1912), a graduate of the Naval Academy, and an officer in the United States Navy.—*W. J. Humphreys.*

DIURNAL DISTRIBUTION OF RAINFALL AT ST. JOSEPH, MO., APRIL TO OCTOBER

By W. S. BELDEN

[Weather Bureau, St. Joseph, Mo., June 1936]

The average annual precipitation at St. Joseph, Mo., as recorded during the years 1910 to 1934, inclusive, is 34.28 inches. Of this amount 26.63 inches, or approximately 78 percent, occurs during the 7 months April to October, inclusive. June and September are the wettest months with averages of 5.03 and 5.02 inches, respectively; while July is the driest summer month with an average of 3.03 inches.

Table 1 gives the normal rainfall by decades and months, April to October, based on the observations over the 25-year period. It will be noted from this table that there is a gradual decrease in rainfall during June and July from a maximum of 2 inches in the first decade of June to a minimum of 0.88 inch in the last decade of July. A secondary maximum of 1.95 inches appears in the middle decade of September, followed by decreasing values with only 0.63 inch in the closing decade of October.

Table 2 gives the percentages of the total rainfall that occurred during the daytime and during the nighttime.[1] Figure 1 shows graphically the values given in table 2. The table and figure present conclusive evidence that nighttime rain is considerably greater in total amount than daytime rain. In July the contrast is greatest, with with about two-thirds of the total July rainfall occurring in the 12-hour period 7 p. m. to 7 a. m. Sixty percent of the rainfall for the 7 months' period occurs during the nighttime and 40 percent during the daytime. On the average the rainfall occurring within the 3-hour period ending at 5 a. m. is more than two and one-half times greater than that falling within the 3-hour period ending at 2 p. m. The hour ending at 4 a. m. has the greatest hourly rainfall, and the hour ending at noon the least.

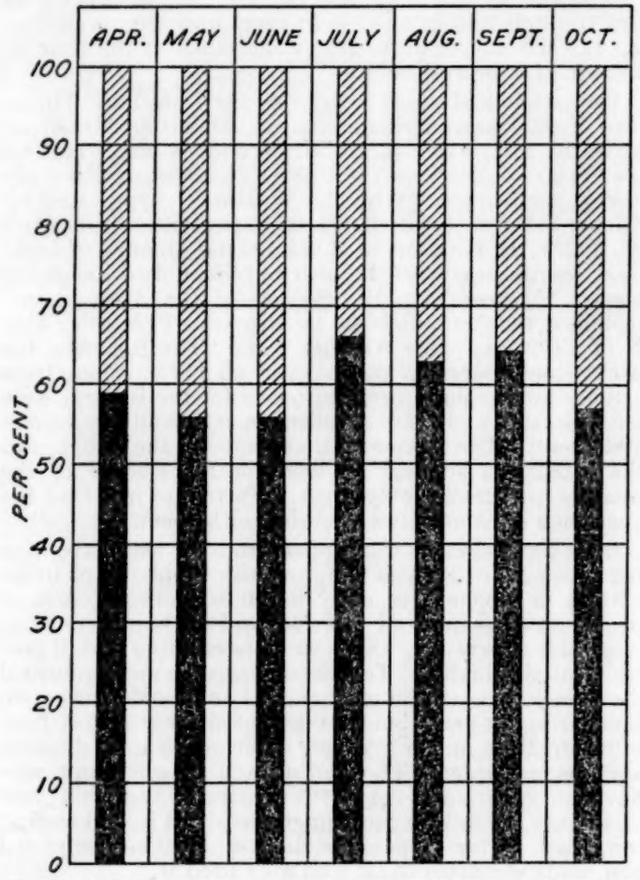

FIGURE 1.—Percentage of the total rainfall occurring at night (7 p. m. to 7 a. m.) and during the day (7 a. m. to 7 p. m.), April to October, inclusive, 1910-34. Solid shading indicates nocturnal percentages (90th meridian time).

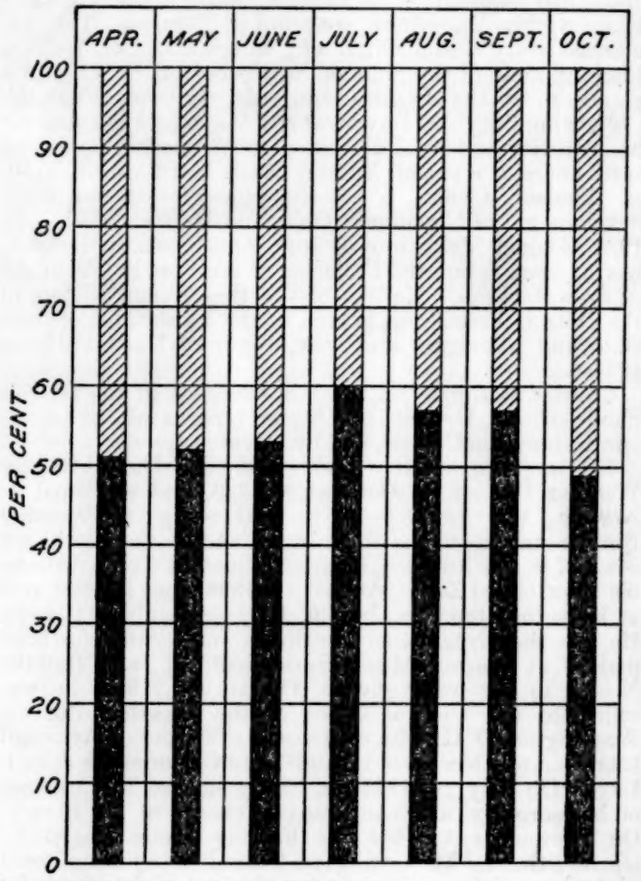

FIGURE 2.—Percentages of total duration of rain occurring at night (7 p. m. to 7 a. m., solid shading) and during the day (7 a. m. to 7 p. m.), April to October, inclusive, 1910-34.

The time during which rain falls is longer at night than during the day, but the difference is not so pronounced as in the case of the amounts of rainfall. Table 3 gives the monthly total duration of daytime and nighttime rainfalls for the 25-year period, and figure 2 shows the percentages graphically. Daytime and nighttime durations are almost equal in April and October; but in the other 5 months, May to September, nighttime rains are more prolonged than daytime rains. In July 60 percent of the total duration of rainfall occurs during the nighttime. The average monthly duration of daytime rains decreases from 33 hours 56 minutes in April to 10 hours 56 minutes in

[1] The terms "day" and "night" as used in this paper, unless otherwise indicated, have reference to the periods from 7 a. m. to 7. p. m. and from 7 p. m. to 7 a. m., respectively, 90th meridian time; the division points correspond to the hours of the regular twice-daily observations at the regular Weather Bureau stations.

July. Nighttime rains during these 4 months, April to July, also have a similar gradual but less marked decrease in duration. In August and September there are corresponding increases in duration of both daytime and nighttime rains, and the increase in duration of daytime rains continues through October.

Table 4 shows the average duration of rains that begin during each hour of the day and night, and table 5 shows the average duration of rains that begin in the daytime and in the nighttime. For the season April to October, inclusive, as a whole, the average duration of rains beginning between 7 a. m. and 7 p. m. is 2 hours 44 minutes; and between 7 p. m. and 7 a. m., 3 hours 57 minutes. Rains beginning within the 5-hour period 8 p. m. to 1 a. m. have an average duration of 4 hours 42 minutes, while rains beginning within the 5-hour period 9 a. m. to 2 p. m. continue on the average 2 hours 47 minutes. Rain beginning between 9 p. m. and 10 p. m. continues for a considerably longer period than rain beginning in any other hour. This is particularly noticeable in the months of April, May, and September. In July rains starting in the nighttime have an average duration of 2 hours 47 minutes as compared with an average duration of 1 hour 23 minutes for rains starting in the daytime. The average length of April rains is 4 hours 28 minutes, while the average length of July rains is 2 hours 5 minutes.

Beginnings and endings of all rains were used in the determination of durations; and when not definitely known they were approximated.

Figure 3 shows the average hourly intensity of rainfall for the season, April to October, inclusive, for the years 1910 to 1934. The intensity increases quite decidedly from 8 p. m. to 10 p. m., after which there is rather a sharp decline to 11 p. m., followed by another increase. The intensity is relatively high during the 5 hours beginning at midnight, while the lowest rate of fall and the lightest hourly amount occur from 11 a. m. to noon.

As pointed out by J. B. Kincer,[2] the distribution and duration of precipitation have an important bearing on agriculture. This study of the precipitation records for St. Joseph, Mo., shows that Nature provides much the greater portion of the rainfall during the warm growing season, and that there is a marked variation in its diurnal distribution, with the greatest concentration of rainfall during the nighttime. In the harvest and threshing period, daytime rains are comparatively infrequent, which is an economic factor of much importance. Nighttime rains occur over a longer period of time and in more generous amounts, thus materially increasing the beneficial effects of rainfall on vegetation.

[2] *See* Monthly Weather Review, 1921, 49:350.

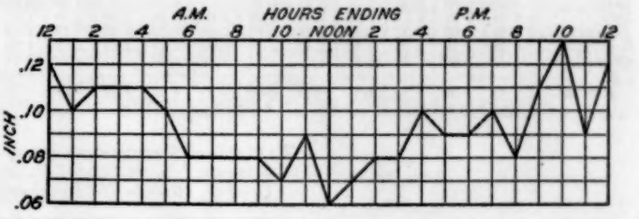

FIGURE 3.—Average hourly intensity of rainfall for the season, April–October, at St. Joseph, Mo. (total hourly accumulated divided by the number of times measurable rainfall was recorded, 1910–34.

TABLE 1.—*Normal rainfall at St. Joseph, Mo., by decades and months, April to October, as determined from records for the years 1910 to 1934 inclusive*

Period	April	May	June	July	August	September	October
	In.	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
1st decade	0.99	1.11	2.00	1.12	1.30	1.67	1.17
2d decade	1.40	1.32	1.58	1.03	1.31	1.95	.89
3d decade	.82	[1] 1.56	1.45	1.88	[1] 1.05	1.40	1.63
Monthly	3.21	3.99	5.03	3.03	3.66	5.02	2.69

[1] For 11 days.

TABLE 2.—*Percentage of total rainfall at St. Joseph, Mo., occurring during the 12-hour periods 7 p. m. to 7 a. m. and 7 a. m. to 7 p. m., April to October 1910 to 1934 inclusive*

Month	7 p. m. to 7 a. m.	7 a. m. to 7 p. m.	Month	7 p. m. to 7 a. m.	7 a. m. to 7 p. m.
	Percent	*Percent*		*Percent*	*Percent*
April	59	41	September	64	36
May	56	44	October	57	43
June	56	44			
July	66	34	Average	60	40
August	63	37			

TABLE 3.—*Monthly total duration (in hours and minutes) of daytime and nighttime rainfalls at St. Joseph, Mo., April to October, during the 25 years 1910–34*

Years	April		May		June		July		August		September		October	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
	H. m.	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*
1910	26 46	19 30	68 49	86 56	16 13	7 06	5 51	6 43	22 24	30 56	24 57	30 43	11 19	6 12
1911	17 42	35 33	14 45	28 23	12 53	1 07	13 29	18 12	4 35	16 11	32 06	34 30	24 49	15 27
1912	15 50	20 33	14 33	18 59	22 57	23 00	9 31	11 45	30 48	12 49	18 04	20 14	30 29	22 44
1913	37 02	43 35	39 46	37 16	10 59	21 24	3 57	6 36	4 19	8 20	24 54	36 39	29 44	35 55
1914	20 17	22 48	11 39	3 10	20 51	24 53	12 32	4 50	4 11	14 45	28 59	27 03	29 50	31 30
1915	24 09	18 21	62 20	56 07	20 59	23 13	27 05	34 58	17 51	15 21	37 17	44 35	6 47	13 35
1916	35 19	28 46	34 37	44 02	21 17	37 03	2 56	6 00	16 30	20 29	10 19	24 53	34 26	24 08
1917	70 20	58 40	38 22	20 46	21 40	16 37	3 54	13 36	19 03	16 35	21 30	15 01	18 37	21 01
1918	30 00	45 32	22 55	32 32	8 59	13 37	17 28	14 29	20 25	38 17	19 41	38 52	39 32	34 29
1919	28 08	33 28	18 31	33 41	29 59	24 30	9 08	8 42	13 57	5 37	25 55	37 25	42 46	24 16
1920	50 40	54 56	33 53	21 19	11 56	12 48	9 10	31 13	16 03	19 00	15 18	35 23	20 49	10 53
1921	41 24	20 14	16 48	28 38	24 18	20 42	4 41	11 28	14 55	29 08	30 44	30 26	11 41	17 02
1922	47 15	41 57	49 06	26 50	5 00	10 09	9 40	29 49	7 37	8 24	15 21	25 20	22 26	27 10
1923	23 00	15 37	21 36	33 38	29 39	19 53	11 43	16 10	29 49	32 22	26 36	21 21	37 26	46 06
1924	10 55	15 41	26 55	39 54	15 37	38 42	18 35	16 38	17 36	27 19	27 02	24 08	14 01	12 25
1925	50 38	25 05	21 51	18 07	21 42	37 32	12 58	11 55	13 11	28 39	44 29	52 23	47 12	37 57
1926	36 42	45 57	6 06	22 20	18 00	16 19	11 52	16 38	16 51	18 40	54 38	97 24	32 03	21 35
1927	58 46	74 16	7 17	20 49	38 06	28 09	11 01	17 06	19 54	32 49	12 44	54 28	14 22	23 06
1928	27 42	23 29	19 09	21 08	43 07	42 36	15 36	19 50	17 12	21 36	5 26	25 52	28 21	36 30
1929	40 11	67 32	35 32	42 43	25 00	29 53	14 23	38 37	6 38	34 45	18 43	14 12	45 04	54 15
1930	28 25	44 55	31 15	30 40	16 34	31 04	14 52	5 07	21 45	29 19	21 40	18 54	42 31	40 01
1931	52 09	52 01	49 37	32 53	10 23	8 35	10 23	22 12	29 59	39 45	30 49	23 40	32 43	28 57
1932	36 57	40 32	14 24	22 44	31 18	17 02	15 41	13 21	21 19	21 21	13 19	18 14	23 43	17 18
1933	30 04	24 46	47 47	34 13	6 26	19 48	2 55	18 01	32 06	48 17	28 24	35 57	3 59	8 57
1934	7 47	17 52	9 30	18 21	6 02	16 32	4 06	11 26	23 04	25 08	43 01	57 53	10 57	18 01
Means	33 56	35 40	28 41	31 03	19 36	21 41	10 56	16 13	17 41	23 50	25 19	33 49	26 13	25 11
Percentages	49	51	48	52	47	53	40	60	43	57	43	57	.51	49

TABLE 4.—*Average duration of rains beginning in the hours indicated for the 25 years 1910–34, at St. Joseph, Mo.*

Month	A. M.												P. M.											
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	Mean
	H. m.	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*	*H. m.*
April	4 36	4 00	6 03	3 09	8 13	2 42	3 52	4 48	3 36	3 58	6 56	2 22	4 43	2 48	1 39	4 24	2 36	2 51	3 35	4 03	5 46	8 49	5 24	6 17	4 28
May	5 51	3 04	2 06	5 19	3 35	5 27	2 19	3 00	4 05	4 22	2 08	4 23	1 21	3 41	3 12	3 52	2 58	1 37	1 08	4 54	4 30	7 05	4 51	1 50	3 37
June	2 00	3 49	2 25	2 31	3 04	1 57	2 07	1 58	1 37	2 44	2 07	1 38	2 59	2 16	2 31	2 55	2 48	2 48	1 34	2 56	3 1°	6 15	^ 44	3 19	2 41
July	4 34	3 03	3 11	1 48	1 54	2 28	2 07	1 26	1 25	0 54	1 31	1 07	1 21	0 52	2 28	1 26	0 49	2 10	1 11	2 11	2 38	2 18	2 40	4 37	2 05
August	4 33	4 02	2 23	4 16	3 18	2 07	2 37	2 16	1 37	2 13	1 53	1 59	2 08	1 17	1 54	1 10	3 47	1 17	3 52	5 19	4 24	3 02	4 36	4 12	2 56
September	5 43	5 59	2 22	3 45	1 42	2 29	2 20	4 19	3 04	2 40	4 25	2 43	1 49	2 39	1 53	1 54	3 40	2 29	4 44	2 58	5 40	8 14	4 56	6 10	3 42
October	5 50	3 36	4 44	4 57	4 25	1 59	4 16	4 59	2 15	4 07	3 27	3 25	5 03	3 28	6 06	1 13	2 59	4 09	2 20	3 37	3 28	5 11	5 39	3 34	3 57
Average	4 44	3 56	3 19	3 41	3 44	2 44	2 48	3 15	2 31	3 00	3 12	2 31	2 46	2 26	2 49	2 25	2 48	2 29	2 38	3 43	4 14	5 51	4 24	4 17	3 21

TABLE 5.—*Average duration of rainfall at St. Joseph, Mo., beginning between 7 p. m. and 7 a. m. and 7 a. m. and 7 p. m., April to October, 1910 to 1934 inclusive*

Month	7 p. m. to 7 a. m.	7 a. m. to 7 p. m.	Month	7 p. m. to 7 a. m.	7 a. m. to 7 p. m.
	H. m.	*H. m.*		*H. m.*	*H. m.*
April	5 14	3 41	September	4 22	3 02
May	4 14	2 59	October	4 16	3 38
June	3 02	2 20			
July	2 47	1 23	Averages	3 57	2 44
August	3 44	2 07			

HEATERS TO PREVENT FROSTING OF THEODOLITE LENSES AT LOW TEMPERATURES

By G. GRIMMINGER

[Weather Bureau, Boston, Mass., July 1936]

When pilot-balloon observations were begun at Little America, Antarctica, in 1934, it was soon found that the formation of frost on the theodolite lenses was going to cause considerable trouble. The frost formation became noticeable at a temperature of about −20° F., increasing in intensity with decreasing temperature. It was due to condensation, on the cold glass, of vapor in the observer's breath and of moisture evaporated from his face, and formed on both the eyepiece and the object lenses.[1] At the beginning of the winter night, with the advent of low temperatures and the use of lanterns, this formation of frost would after several minutes make it impossible to see the lantern attached to the balloon; and the observer would then have to stop observing and scrape the two lenses with a small piece of wood once or twice a minute; this, of course, made it difficult to keep the lantern in the field, and in some cases was responsible for losing the balloon entirely. This same difficulty was also experienced by Sverdrup on the *Maud* Expedition.[2]

To remedy the trouble, two simple but effective heaters were devised. The objective heater consisted simply of a 15-watt electric light bulb. This bulb was placed under the theodolite barrel, with the end of the bulb flush with the object lens; around the bulb and theodolite barrel was then wrapped a single layer of asbestos-covered wire mesh, and around this was wrapped a number of turns or ordinary friction tape. The asbestos-covered wire mesh prevented the bulb from burning the tape, and the tape kept the bulb securely fastened to the barrel of the theodolite and at the same time completely protected it from drift and snow. Leads were run from the bulb socket to our building nearby and tapped into a 110-volt line, the current for which was supplied by a gasoline generator. The heat from the lighted bulb heated the end of the theodolite barrel near the objective, and this in turn heated the lens by conduction, preventing any frost formation whatsoever.

This type of device was too bulky for the eyepiece and would not give the observer an unobstructed view of the theodolite scales; hence a resistance type of heater was used here. It consisted of a piece about three-fourths of an inch long cut from a larger resistance unit found among the electrical equipment and made of resistance wire wound on a ceramic tube. With a little filing of the inside of the tube it was easily made to slip on over the end of the eyepiece with a snug fit after the aperture disk had been removed. Leads were run from this resistor into the building where they were connected to a 6-volt storage battery. Although the ceramic tube was an insulator, it was quite thin and plenty of heat got through it to heat the eye-piece tube which in turn conducted heat to the lens. Although no note was made of the size and number of turns of wire used, the resistance was probably about four ohms. The storage battery was used to operate the timing device and theodolite lighting system as well as the eyepiece heater and had to be charged only two or three times during the year.

Although they were rather crude makeshift affairs, both of these heating devices proved very effective, and no frosting of the lenses was experienced after they were put into use. In cases where a 110-volt current is not available, a resistance heater could also be devised for the object lens and operated with a storage battery.

Experience also proved that a long eyepiece tube was much better than a short one. A small-size type of theodolite which was used for several days was quite unsatisfactory because the shortness of the eyepiece tube brought the observer's face and breath so close to the theodolite scales that they frosted over and became difficult to read after a short time.

[1] Scientific results of the *Maud* Expedition, Vol. 2, Meteorology, Part 1, Discussion by H. U. Sverdrup, p. 41.
[2] Ibid., p. 41.

ANALYSIS OF RAINS AND SNOWS AT MOUNT VERNON, IOWA, 1935–36

By NICHOLAS KNIGHT

[Cornell College, Mount Vernon, Iowa, June 1936]

During the year 1935–36, 51 samples of precipitation were analyzed in the Cornell College chemical laboratories. There were 29 samples of rain and 22 samples of snow.

The rains of October 13 and 31, 1935, were accompanied by thunder and lightning. In the 0.10 of an inch rainfall on November 10, the chlorine, nitrates, and nitrites were unusually high. These results show what one would naturally expect, that most of these substances are dissolved in the first part of an ordinary precipitation. The same is true of the sulphate. Our experiments tend to show that the sulphates in the Mount Vernon precipitations come from the sulphur in the coal that is burned.

On January 4, 1936, the precipitation was both rain and snow equivalent to 0.2 of an inch rain. In Chicago the storm was accompanied by thunder and lightning.

TABLE 1.—*Parts per million*

Date	Rain or snow	Chlorine	Free NH_3	Alb. NH_3	N in nitrite	N in nitrite	Sulphate SO_3
1935							
June 6	Rain in 0 to 0.3	3.55	0.056	0.04	0.3	0.00	0.08
16	0.6 inch	2.13	.04	.05	.55	.00	.00
18	1.2 inches	3.00	.20	.02	.25	.00	.00
Oct. 10	0.5 inch	3.55	.40	.72	.15	.05	.05
13	0.35 inch	2.13	.22	.16	.09	.05	.00
17	½ inch rain	1.42	.24	.24	.20	.25	.01
21	¼ inch rain	3.55	.40	.32	.04	.10	.003
31	½ inch rain	2.00	.20	.04	.035	.09	.00
Nov. 4	2.6 inches rain	3.55	.08	.24	.06	.16	.00
10	1/16 inch rain	7.10	X	X	.25	.47	.025
19	9/10 inch rain	2.13	.32	.30	.30	.35	.005
27	1¼ inch rain	2.00	.056	.40	.11	.46	.00
28	2 inches rain	.71	.050	.24	.15	.09	.008
Dec. 7	½ inch rain	2.50	.025	.65	.20	.40	.007
15	4 inches snow	3.55	.112	.80	.20	.10	.005
23	do	2.13	.08	.36	.25	.08	.003
25	4 inches snow	3.55	.24	.03	.25	.15	.003
28	2 inches snow	3.75	.20	.32	.15	.25	.005
1936							
Jan. 2	6 inches snow	2.15	.02	.40	.08	.30	.005
4	0.4 inch rain	1.42	.40	.40	.35	.20	.005
6	2 inches snow	3.55	.28	.40	.15	.25	.005
7	¼ inch snow	1.42	X	X	.19	.60	X
8	3 inches snow	2.13	.08	.40	.075	.30	.00
16	2 inches snow	1.40	.136	.24	.10	.35	.002
18	9 inches snow	.71	.056	.22	.05	.25	.002
22	2 inches snow	7.10	.45	.20	.15	.45	.005
29	2 inches snow	3.40	.24	.112	.15	.20	.00
Feb. 4	4 inches snow	2.13	.45	.36	.20	.12	.006
9	3 inches snow	2.80	.45	.32	.10	.25	.003
12	do	1.42	.32	.45	.20	.25	.005
14	2 inches snow	2.10	.40	.32	.17	.25	.0044
17	do	2.13	.24	.32	.12	.35	.00
26	0.2 inch rain	3.55	.50	.80	.15	.40	.010
Mar. 11	½ inch rain	2.10	.28	.45	.13	.33	.009
14	3 inches snow	3.55	.24	.44	.175	.30	.002
19	0.02 inch snow	3.55	.24	.48	.23	.50	.016
Apr. 1	2 inches snow	.9	.40	.20	.10	.20	.004
2	3 inches snow	3.55	.16	.38	.10	.50	.00
5	do	3.55	.45	.28	.10	.35	.006
14	0.12 inch rain	2.84	.80	.50	.17	.50	.007
20	¼ inch rain	3.55	.42	.44	.20	.30	.00
24	1/10 inch rain	2.13	X	X	.25	1.00	.025
27	7/10 inch rain	1.42	.42	.40	.30	.5	.004
1936							
May 1	⅛ inch rain	3.55	.40	.20	.20	.05	.007
4	1/10 inch rain	7.10	X	X	.10	.12	.004
10	do	3.55	X	X	.20	.03	.002
12	⅛ inch rain	2.00	.24	.16	.15	.02	.004
23	⅜ inch rain	2.13	.45	.40	.10	.15	.04
June 12	2.9 inches rain	.6	.24	.16	.10	.02	.004
6	0.3 inch rain	1.42	.40	.42	.16	.02	.009
9	1.2 inches rain	2.00	.38	.50	.10	.015	.004

TABLE 2.—*Pounds per acre*

Date	Rain or snow	Chlorine	Free NH_3	Alb. NH_3	N in nitrate	N in nitrite	Sulphate SO_3
1935							
June 6	3 inches rain	0.24	0.04	0.003	0.02	0.00	0.005
16	0.6 inches rain	.29	.005	.007	.075	.00	.00
18	1.2 inches rain	.81	.05	.005	.068	.00	.00
Oct. 10	0.5 inch rain	.4	.045	.08	.017	.006	.0057
13	0.35 inch rain	.17	.018	.13	.007	.004	.00
17	½ inch rain	.114	.019	.019	.029	.016	.008
21	¼ inch rain	.2	.023	.018	.0023	.006	.0002
31	½ inch rain	.23	.023	.005	.004	.01	.00
Nov. 4	2.6 inches rain	2.09	.047	.014	.035	.095	.00
10	1/16 inch rain	.16	X	X	.0058	.011	.0006
19	9/10 inch rain	.1449	.022	.02	.02	.024	.0004
27	1¼ inches rain	.56	.016	.112	.031	.13	.0003
28	2 inches snow	.067	.002	.009	.006	.003	.0003
Dec. 7	½ inch rain	.28	.03	.07	.023	.046	.0008
15	4 inches snow	.16	.085	.09	.019	.0075	.0004
25	do	.27	.016	.0023	.019	.011	.0002
28	2 inches snow	.15	.008	.0012	.006	.01	.0002
1936							
Jan. 2	6 inches snow	.245	.0023	.046	.009	.034	.0006
4	0.2 inch snow	.54	.015	.015	.013	.008	.002
Dec. 23	4 inches snow	.162	.0061	.027	.019	.006	.0023
Jan. 6	2 inches snow	.16	.013	.018	.007	.011	.0002
7	¼ inch snow	.007	X	X	.001	.0030	X
8	3 inches snow	.12	.0046	.023	.0057	.017	.00
16	2 inches snow	.052	.005	.009	.0004	.013	.0007
18	9 inches snow	.12	.110	.037	.0085	.0425	.0003
22	2 inches snow	.263	.017	.007	.006	.017	.0002
29	do	.13	.009	.004	.0056	.007	.00
Feb. 4	4 inches snow	.162	.034	.027	.015	.009	.0005
9	3 inches snow	.16	.026	.018	.006	.014	.0002
12	do	.081	.018	.026	.0114	.014	.0003
14	2 inches snow	.08	.015	.0122	.0065	.009	.0002
17	do	.081	.009	.0122	.0046	.013	.0038
26	0.2 inch rain	.16	.0225	.036	.0008	.018	.0004
Mar. 11	0.5 inch rain	.24	.032	.051	.0147	.037	.001
14	3 inches snow	.20	.014	.0251	.010	.017	.0001
19	2 inches snow	.135	.009	.018	.19	.009	.0061
Apr. 1	do	.034	.015	.008	.004	.008	.002
2	3 inches snow	.20	.009	.022	.0057	.029	.00
5	do	.20	.016	.026	.0057	.0209	.0004
14	0.12 inch rain	.077	.022	.014	.0046	.013	.0002
20	0.25 inch rain	.20	X	X	.011	.017	.00
24	1/10 inch rain	.05	.024	.025	.008	.023	.0006
27	7/10 inch rain	.227	.067	.064	.048	.08	.0006
May 1	⅛ inch rain	.016	.018	.009	.009	.002	.0002
9	1/10 inch rain	.16	X	X	.002	.003	.0001
10	do	.08	X	X	.0046	.0009	.00005
12	⅛ inch rain	.096	.011	.007	.007	.0009	.0002
23	⅜ inch rain	.20	.041	.036	.009	.0014	.0036
6	0.3 inch rain	.10	.027	.029	.011	.0014	.0006
9	1.2 inches rain	.54	.103	.14	.01	.0041	.0011
June 12	2.9 inches rain	.40	.16	.11	.066	.013	.003

SEA SWELLS IN RELATION TO MOVEMENT AND INTENSITY OF TROPICAL STORMS

By I. R. TANNEHILL

[Marine Division, Weather Bureau, Washington, July 1936]

Tropical storms, like other phenomena that cause disturbances of the sea surface, result in the formation of waves which move outward in all directions from the region of origin. The precursory indications given by sea swells preceding the storm are generally appreciated, and have been discussed by a number of writers. Of these, mention may be made of Lt.-Col. William Reid [1] who prepared the diagram of swells and cross seas reproduced in figure 1. Other investigators have studied waves caused by storms at sea, notably Cornish,[2] Wheeler,[3] and Fleming.[4] The effects of a storm's progressive travel on the character and direction of movement of sea swells in the various parts of the storm area have been discussed by Cline [5] who originated the diagram reproduced in figure 2.

[1] Reid, Lt.-Col., William. The Progress of the Development of the Law of Storms and of the Variable Winds. London, 1849.

[2] Cornish, Vaughn. Ocean Waves. Cambridge, 1934.
[3] Wheeler, W. H. A Practical Manual of Tides and Waves: London, 1906.
[4] Fleming, J. A. Waves and Ripples. London, 1912.
[5] Cline, I. M. Relation of Changes in Storm Tides on the Coast of the Gulf of Mexico to the Center and Movement of Hurricanes. MONTHLY WEATHER REVIEW. 48: 127–146. March 1920.

Cline presented no observations of swells at sea to support his conclusions, which appear to be based on theoretical considerations. In all of these investigations very little has been done with actual observations of swell in tropical cyclones.

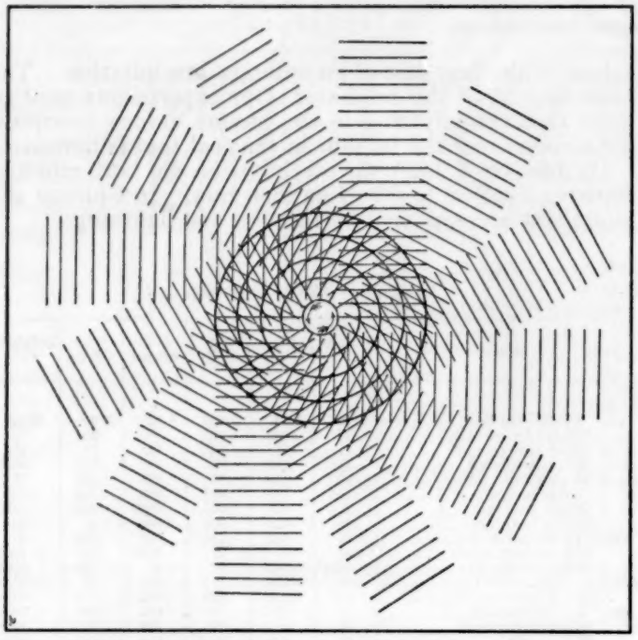

FIGURE 1.—Swells and cross seas in a hurricane, according to Reid.

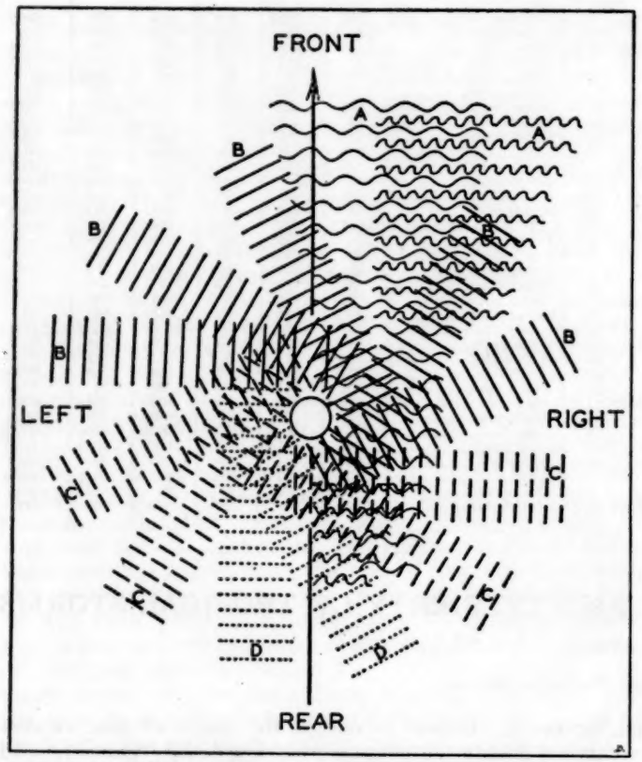

FIGURE 2.—A. Swells of greatest length and magnitude, traveling in the line of advance of the hurricane. B. Swells and waves of moderate length and magnitude in the front segment of the hurricane, moving outward to right, and left of the line of advance. C. Swells and waves of smaller length and lesser magnitude in the rear segment of the hurricane, moving outward to right, and left of the line of advance. D. Swells and waves of least magnitude moving outward from the rear of the hurricane.—*I. M. Cline.*

During the hurricane season of 1935, the Weather Bureau was enabled by a special appropriation to secure for the first time by radio, daily reports of swells from ships at sea in connection with hurricanes. Systematic observations of sea swells were begun also at Coast Guard stations in 1935. This reorganization of the hurricane reporting service has been described by Calvert.[6]

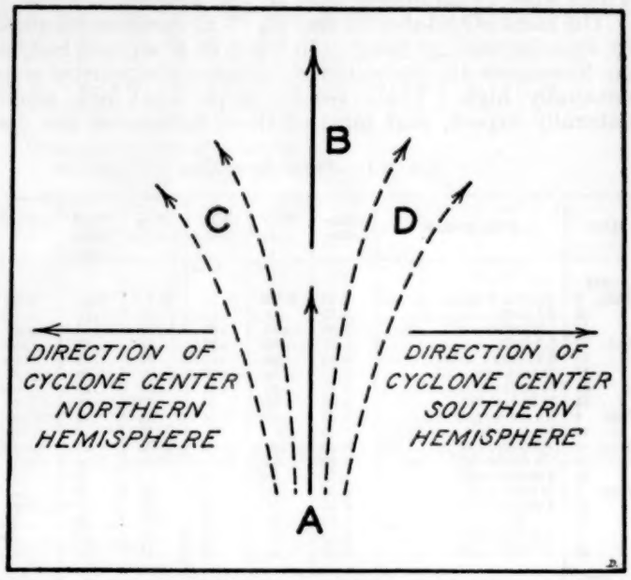

FIGURE 3.—Deviation of wind (dotted arrows) from waves (solid arrows) in tropical cyclones of both hemispheres.

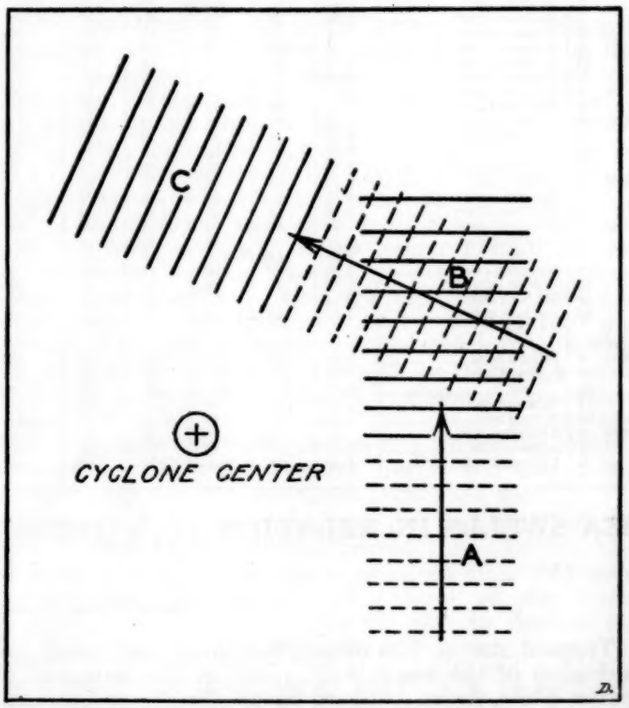

FIGURE 4.—Dominant waves (solid lines) moving into wind fields where new waves (dotted lines) are being developed.

With the ultimate object of aiding the mariner to secure the greatest practical benefit from the observations of swell now collected by radio, the writer has prepared a

[6] Calvert, E. B. The Hurricane Warning Service and Its Reorganization. MONTHLY WEATHER REVIEW. 63: 85-88, March 1935.

number of synoptic charts for a study of wind and swell attending tropical cyclones. The charts reveal features of movement of swell which have not, to the author's knowledge, been previously described in print. This paper is intended as a preliminary discussion of the available observations of sea swell in connection with tropical cyclones.

CHARACTERISTICS OF WAVES CAUSED BY WINDS

When wind begins blowing over a water surface it produces at first a series of ripples moving with the wind. As the ripples move forward with the wind, they steadily increase in size so long as the wind continues. The ultimate size of the waves depends upon the force of the wind and the "fetch" or length of water surface to windward. Thomas Stevenson's formula for the maximum height of a wave in relation to length of fetch is

$$H=1.5\sqrt{L},$$

where H is the height of the wave in feet and L the length of fetch in nautical miles. For a body of deep water 9 miles in length the maximum wave would be 4½ feet in height; for a stretch of 900 miles of deep sea, the maximum wave height would, theoretically, be 45 feet.

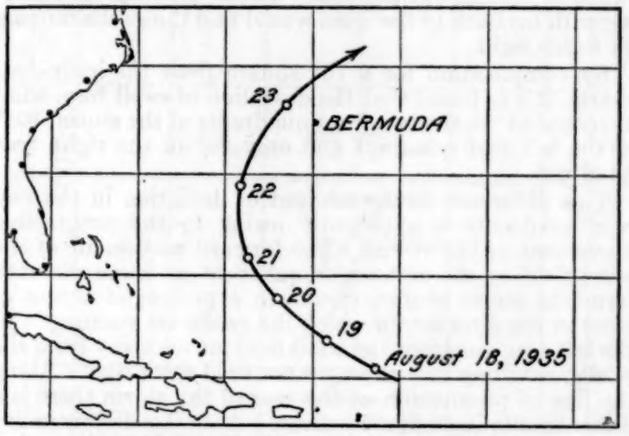

FIGURE 5.—Partial track of hurricane of August 18 to 25, 1935.

The relation of fetch to size of wave is of considerable importance in dealing with tropical cyclones; the length of fetch is only a fraction of the storm diameter, and not necessarily the length of the gulf or sea in which the storm lies.

After the wave moves beyond the influence of the winds which caused it, there is a change in its form. The most rapid change at first is a decrease in height. The wave becomes a relatively low, undulating movement of the sea surface known as a swell. To the mariner a swell is distinguished by two features; first, its relatively smooth, undulating form without the steep and ragged crests characteristic of waves actively driven by the wind and, second, the movement of winds and waves in different directions indicating that the waves have been formed elsewhere by winds from another quarter. There is no very satisfactory definition of swells as distinguished from ordinary wind-driven waves because there is an endless variety of conditions of wind and swell, sometimes with newly developed waves moving across the swells. The typical case is the sea swell moving far in advance of the storm into regions where winds are of insufficient force to produce any local confusion of the sea surface.

According to Cornish [2] the speed of deep-sea waves in statute miles per hour is obtained approximately by multiplying the period in seconds by 3½. The period is the time between the passage of successive crests, taken as an average for the series of wave crests passing in 1 minute or, preferably, 3 minutes. Hence a swell with a period of 12 seconds (or 5 swells per minute) would be moving at 42 miles an hour. The length may be obtained roughly by multiplying the square of the period in seconds by 5⅓, giving a length of 738 feet for a wave with a period of 12 seconds.

Many estimates of wave dimensions have been recorded in the open ocean. However, it is difficult to make accurate estimates from shipboard; and neither on the open sea nor from the shore have wave observations frequently been associated with accurate measurements of wind speed at the place of observation. Seldom has the investigator been adequately informed as to the wind movement over the considerable stretches of sea surface on which the waves are produced. Hence, the relation between waves and wind in the open ocean has been deduced chiefly from series of rather rough estimates of both wind and wave.

The relative proportions of waves caused by winds of various forces cannot be worked out to complete satisfaction by formula. The length of wave may vary from 5 to 30 times the height in short waves, and from 10 to 40 times the height in long waves. The dimensions of the wave depend upon many factors, such as the speed and gustiness of the wind, the fetch, the changes in direction and the persistence in any given direction, all of which are difficult to estimate for a long stretch of open water surface; hence calculations from formulas are only rough approximations.

The relations stated in the foregoing paragraphs apply to waves finally produced by winds blowing over long stretches of open ocean. Actually there are limitations to the length of fetch of the wind in any given direction. In cyclonic systems, the winds do not blow over great distances in approximately straight lines. The greatest fetch of gale winds is usually found in extratropical cyclones of large diameter where the direction of the wind over a large area coincides roughly with the direction of travel of the cyclone, and the rate of travel of the cyclone is comparable to the speed of the swells. In tropical cyclones the fetch is considerably less than in extratropical cyclones of large diameter and, although the winds are much more violent, observations indicate that the maximum waves possible for such wind velocities are not actually developed because of insufficient fetch.

OBSERVATIONS OF SWELLS IN TROPICAL CYCLONES AT SEA

In the southern North Atlantic Ocean, including the Caribbean Sea and Gulf of Mexico, tropical cyclones have an average progressive movement of only about 12 miles an hour. Hence, the waves developed by the winds of the storm, moving at speeds of 30 to 50 miles and more an hour, soon pass through the wind system of the cyclone, even when the direction of wave movement and storm travel are coincident. Waves in the open sea do not involve a bodily transfer of water and are not subject to the deflective effect of the earth's rotation; but the winds are deflected and in the Northern Hemisphere are directed counterclockwise around the cyclone center. After waves are formed by winds in any part of the storm area, they move straight forward, while the winds turn to the left in the Northern Hemisphere and to the right, or clockwise,

[2] Cornish, Vaughn. Ocean Waves. Cambridge, 1934.

in the Southern Hemisphere. This is illustrated in figure 3. If the winds represented by the dotted arrows at A produce waves moving in the direction shown by the solid arrow at A, the waves move straight onward as shown by the solid arrow at B. If the winds are part of a tropical cyclone in the Northern Hemisphere, they turn to the left as shown by the dotted arrows at C; if they are part of a tropical cyclone in the Southern Hemisphere, they turn to the right as shown by the dotted arrows at D. This deviation of wind from swell is found in all quadrants of the tropical cyclone. However, observations show that the amount of deviation in any quadrant depends upon the direction and rate of travel of the cyclone.

In any part of the cyclone the dominant swells are those produced to the windward. Some time is required for the winds to develop large waves, and by the time they approach maximum development they are moving rapidly straight forward while the winds have turned to the left (in the Northern Hemisphere) and are developing new

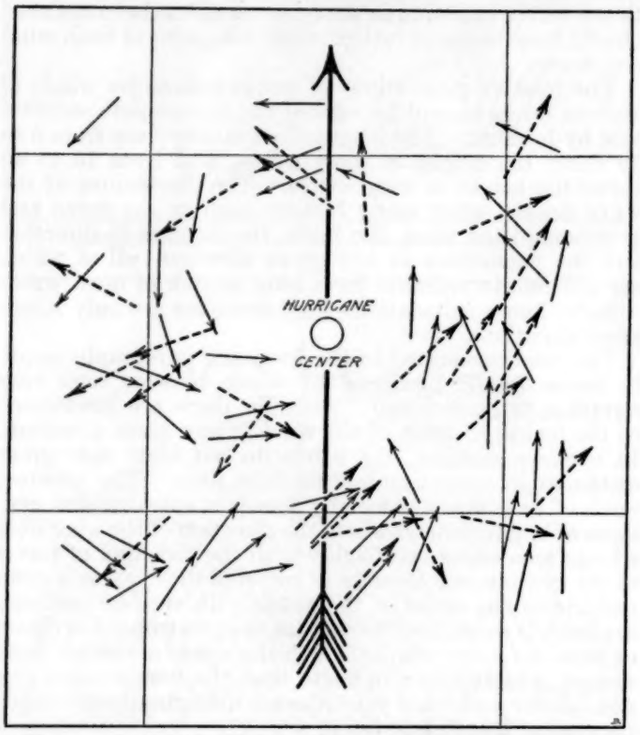

FIGURE 6.—Composite chart showing direction of swells (dashed arrows) and direction of wind (solid arrows) in tropical cyclone, August 20-22, 1935. Large arrow shows direction of storm travel.

waves in another direction. This is shown in figure 4, where the winds at A are producing the waves shown there by dotted lines; those waves become the dominant waves (solid lines) moving into the wind field at B where new waves (dotted lines) are being developed, later to become in turn the dominant waves at C.

That this is the case is clearly shown by observations in the lee of islands within the tropical cyclone. The dominant waves are dissipated on reaching the island; and to the leeward of the island the only waves present are those in process of development and moving in the same direction as the wind. Thus, in figure 4, an island intervening between A and B will prevent the waves developed at A from entering the area B, and the dominant waves in the lee of the island will then be the smaller waves, indicated by dotted lines in the area B.

On the 18th of August 1935, a tropical storm appeared to the northeastward of Puerto Rico. It moved slowly northwestward, then recurved to the northeastward and passed a short distance to the northwest of Bermuda on the 23d. Owing to its relatively slow progressive movement and its location in the open ocean from the 20th to 22d, inclusive, this storm afforded an excellent opportunity for the study of sea swells. The path of the storm is shown in part in figure 5. During these 3 days, ships' weather observations were secured by the Weather Bureau at intervals of 6 hours—at 0000, 0600, 1200, and 1800 G. M. T. Many of the reports contained observations of swells in the international code, giving character of the swells and the direction from which they were moving.

From these reports, 12 synoptic maps were prepared showing direction of wind and swell. These 12 maps were then combined to form the composite chart shown in figure 6. Each of the individual maps was oriented so that the line of progression of the storm center lay on the central meridian of the composite chart before transferring the observations. Thus the movement of wind and swell is shown in the figure in a 7° ocean square as related to a storm center with a progressive movement due northward.

The observations in figure 6 show the deviation of swells to the right of the wind; that is, an observer standing with his back to the wind would find the swells moving off to his right.

By computation for a 10° square from the individual charts, it was found that the deviation of swell from wind averaged 61° in the two front quadrants of the storm, 104° in the left rear quadrant and only 20° in the right rear quadrant.

This difference in the amount of deviation in the two rear quadrants is apparently owing to the progressive movement of the storm. The forward movement of the wind field in the right rear quadrant, at some distance from the storm center, results in a prolonged action of wind in the direction in which the swells are running. In the left rear quadrant the wind field moves away from the swells, resulting in a more pronounced deviation. Along the line of progression at the rear of the storm there is a discontinuity in swell movement. A similar discontinuity is shown in the observations in connection with other tropical storms; it appears to be a genuine feature of the movement of swell in traveling cyclones.

In front and to the right of the storm center the swells in general move forward roughly in the direction of travel of the storm or a little to the right. If the storm continues to move in the same direction over the ocean, these swells become larger and reach far in advance of the storm. It is worthy of note that this feature of movement of swell as shown by actual observations agrees with the conception of Cline as illustrated in figure 2.

The tropical storm previously mentioned as appearing northeast of Puerto Rico on August 18, 1935, was encountered by a number of steamers, including the S. S. *A. C. Bedford*. On the 20th, at noon G. M. T., the *A. C. Bedford* was at 31°45′ N., 68°00′ W., bound for Cartagena. The wind was east to east-southeast with an increasing swell from the south. By 0600 G. M. T. of the 21st, there was a long heavy swell from the south, wind east, force 7. The swell became confused by noon of the 21st, direction south. This situation continued until 0600 G. M. T. of the 22d when the ship was in latitude 28°22′ N., 66°24′ W. The chart given as figure 7 shows the location of the *A. C. Bedford* at 0600 G. M. T. on August 21 and 22 and at

subsequent times of observation, with wind and directions of swell for each, and also corresponding positions of the storm center. By noon of August 23 the ship had passed beyond the wind field of the storm but was still experiencing a long swell, which by that time was coming from the northwest.

From 0600 G. M. T., August 22, to the same hour on August 23, *A. C. Bedford* made little progress against head winds and seas, hence it is not practicable to enter the intervening observations on the map in figure 7. The map shows, however, the changes in direction of swell as the ship passed through the storm field. In each instance the observer on shipboard, facing in the direction from which the swell came, would have found the storm center on his right and the wind coming from a point on his left,

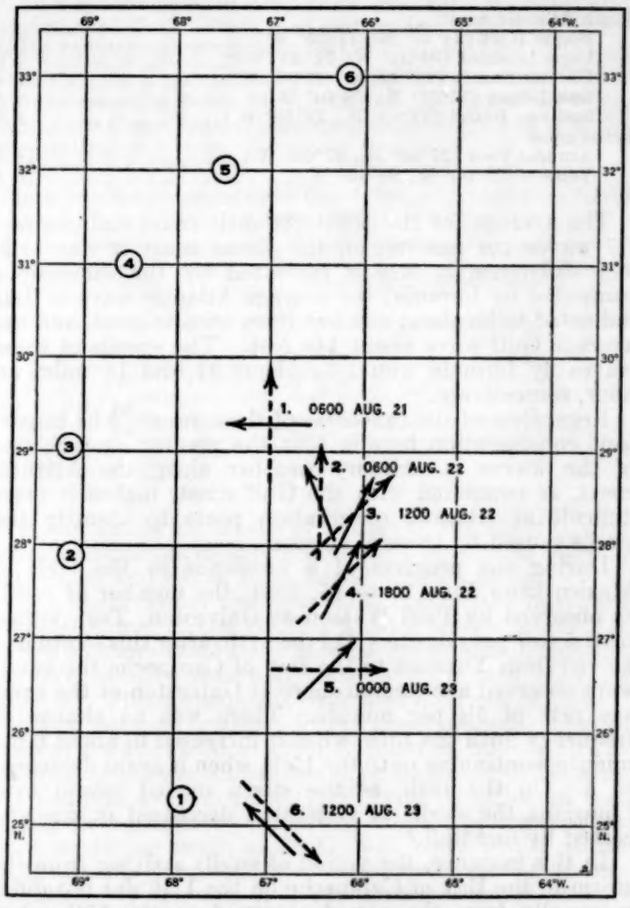

FIGURE 7.—Wind direction (solid arrows) and movement of swell (dashed arrows) observed on S. S. *A. C. Bedford* in hurricane, August 21–23, 1935.

except that the wind and swell came from opposite directions at observation numbered "6", the wind at that time being no longer definitely related to the storm.

Figure 8 shows wind and movement of swell at some distance from the center of a tropical storm in the western Caribbean Sea, at 0000 G. M. T., on September 27, 1935. No reports were received nearer the storm center. The apparent line of discontinuity in movement of swell at the rear of the cyclone is shown by the double dashed line. The ship reports in this instance also showed very clearly the deviation of winds to the left of the swells.

The maps discussed herein have been selected to portray conditions attending cyclonic storms in the open sea. It is believed that they show what will actually appear whenever careful observations of swell are secured from cyclonic storm areas in such situations. However, there are observations on many of the maps that require interpretation both as to accuracy of observation of sea swells and the effect of land areas on their development.

From an examination of many observations of swell and wind from ships at sea it appears that, in the absence of a cyclonic storm, there is little or no deviation between wind and swell. As a test, 50 reports taken at random

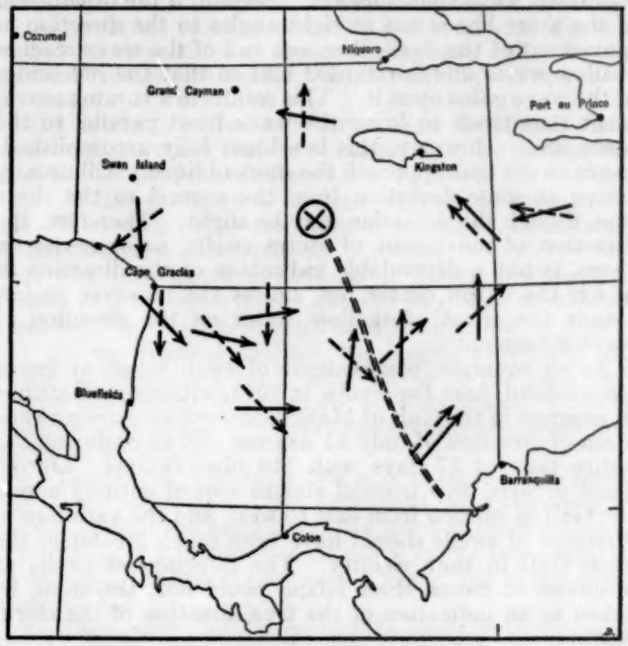

FIGURE 8.—Wind direction (solid arrows) and movement of swell (dashed arrows) in hurricane in Caribbean Sea, 0000 G. M. T., September 27, 1935.

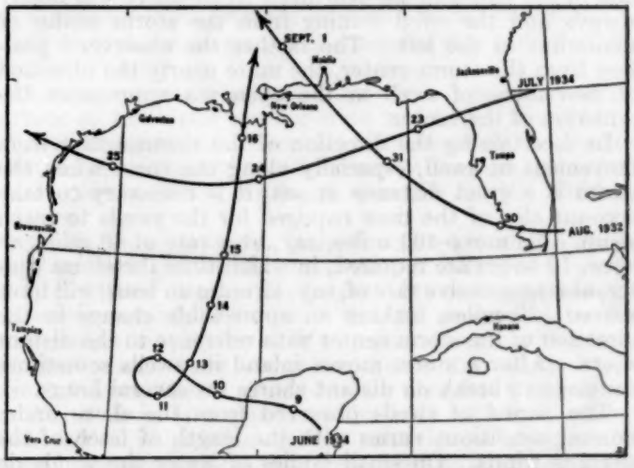

FIGURE 9.—Tracks of tropical cyclones causing heavy swells on the Gulf Coast.

from the Caribbean Sea in August 1935, when no cyclonic storm was in progress, showed an average deviation of less than one degree between wind and swell. There are individual cases of considerable deviation, apparently attributable to temporary or local wind variations, but these appear to be as likely to occur in one direction as another so that on an average the deviation between the trade wind and its swells in the Caribbean Sea appears to be practically nil.

OBSERVATION OF SWELL AT COASTAL STATIONS

The period of waves created by a storm at sea does not change materially as the waves move out of the storm field; even when the swells reach shore, where the waves move more slowly, they become shorter so that the time interval is not affected.

On approaching shore the storm swell appears to be affected in two ways. First, on reaching shallow water, the lower part of the wave meets with resistance, and the top of the wave spills forward. Second, if the orientation of the shore line is not at right angles to the direction of movement of the swell, then one end of the wave reaches shallow water and is retarded first so that the remainder of the wave gains upon it. This results in a turning movement that tends to bring the wave front parallel to the shore line. However, this is seldom fully accomplished, hence swells that approach the shore obliquely will usually arrive at some deviation from the normal to the shore line, though the deviation may be slight. Therefore, the direction of movement of storm swells, as observed on shore, is not a dependable indication of the direction in which the storm center lies, unless the observer understands the effect of shallow water on the direction of wave movement.

As an example, observations of swell taken at Santa Rosa Island, near Pensacola, in 1933, with tropical storms in progress in the Gulf of Mexico, showed an extreme variation of direction of only 45 degrees (SE to S) during the entire time of 17 days with 110 observations. During these periods, two tropical storms moved entirely across the Gulf of Mexico from east to west, and the variation in direction of swells should have been much greater in the open Gulf in that vicinity. The direction of swells as observed at Santa Rosa Island could not, therefore, be taken as an indication of the true direction of the storm center.

From the observations charted in connection with this study, it is evident that the observer facing in the direction of the storm in the Northern Hemisphere will nearly always find the swell coming from the storm center or somewhat to the left. The farther the observer's position from the storm center, the more nearly the direction of movement of swell in the open sea approaches the direction of the center.

In ascertaining the direction of the storm center from movement of swell, especially along the coast when the storm is a great distance at sea, it is necessary to take account also of the time required for the swells to reach shore. To move 400 miles, say, at a rate of 40 miles an hour, 10 hours are required, in which time the storm center, at a progressive rate of, say, 12 miles an hour, will have moved 120 miles, making an appreciable change in the direction of the storm center with reference to the distant shore. After a storm moves inland its swells sometimes continue to break on distant shores for several hours.

The period of swells observed from the shore under normal conditions varies with the length of fetch of the average winds. On small bodies of water the winds do not create waves of long period. On the shore of Corpus Christi Bay, for example, the writer has often observed waves created by the afternoon sea breeze in summer. These waves arrive at the rate of about 20 to 24 per minute, indicating that they are relatively short waves moving at a rate of about 10 miles an hour. At Galveston the usual sea wind of summer from the open Gulf is not so strong as at Corpus Christi but it is accompanied by waves arriving at the rate of about 12 to the minute or with a probable speed of about 18 miles an hour.

Along the Atlantic coast the average wave is much larger than on the coast of the Gulf of Mexico. The averages of numbers of waves per minute as observed at Coast Guard stations along the South Atlantic coast and on the Texas coast from September 1 to 28, 1935 are shown in table 1. Two regular observations were taken daily. Records for stations having less than 50 of the scheduled observations during the period were omitted.

TABLE 1.—*Average number of waves per minute*

South Atlantic coast:	
Bogue Inlet (34°40′ N., 77°05′ W.)	6.7
Cape Lookout (34°40′ N., 76°30′ W.)	7.6
Chester Shoals (28°30′ N., 80°30′ W.)	7.6
Oak Island (33°53′ N., 78°04′ W.)	9.1
Sullivan Island (32°45′ N., 79°50′ W.)	7.6
Texas coast:	
Aransas Pass (27°50′ N., 97°03′ W.)	11.5
Velasco (29°00′ N., 95°15′ W.)	10.8

The average for the South Atlantic coast stations was 7.7 waves per minute; on the Texas coast it was 11.2. The difference in size is indicated by the dimensions computed by formula; the average Atlantic wave is thus indicated to be about 400 feet from crest to crest, and the average Gulf wave about 140 feet. The speeds of these waves by formula would be about 31 and 18 miles an hour, respectively.

Regardless of the exactness of these results, the important consideration here is that the greater average size of the waves in ordinary weather along the Atlantic coast, as compared with the Gulf coast, makes it more difficult at Atlantic observation posts to identify the swells caused by tropical storms.

During the progress of a hurricane in the Gulf of Mexico from June 10 to 15, 1934, the number of swells as observed by Paul Watson at Galveston, Tex., varied from 5 to 7 per minute. On the 11th, after this storm had moved from Yucatan to the Bay of Campeche the swells were observed arriving on shore at Galveston at the average rate of 5½ per minute. There was no change in frequency until the 13th, when it increased to about 6 per minute, continuing until the 15th, when it again decreased to 5. On the 16th, as the storm moved inland over Louisiana the swells at Galveston decreased in size and ceased by nightfall.

In this instance, the period of swells arriving from the storm in the Bay of Campeche on the 11th did not differ materially from the period observed on the 15th when the storm was approaching Louisiana and was much nearer to Galveston.

In July 1934, a disturbance apparently originated off the Atlantic coast and pursued an erratic course across Florida and the Gulf of Mexico. It was of slight intensity until it passed south of Louisiana on the 24th of July; at that point it increased rapidly in intensity. Coincident with or shortly after this development, the period of the swells at Galveston increased. As recorded by Watson, the observations are shown in table 2:

TABLE 2.—*Observations of swell, Galveston, July 24, 1934*

Time	Character and motion of swells	Number of swells per minute
10 a. m.	No swell	
11 a. m.	Waves	14
12 a. m.	Slight swell ESE	10
1 p. m.	Swell ESE	7½
2 p. m.	Broken swells	6½
3 p. m.	Stronger swells	6
4 p. m.	Rough sea SE	5½
5 p. m.	Heavy swells, broken	5
6 p. m.	Very rough, cross seas	5
7 p. m.	SSE	5

In this instance, increase in storm intensity was attended by an increase in size of swells.

In a similar case, in August 1932, a tropical disturbance approached the Coast Guard station on Santa Rosa Island with increasing intensity. The observations of swell, taken by the Coast Guard personnel up to noon of August 31 are given in table 3. Owing to the approach of the storm the Coast Guard personnel were obliged to abandon the station at 1 p. m.

TABLE 3.—*Observations at Coast Guard Station at Santa Rosa Island, August 1932*

Time	Character and direction of swells	Number per minute
Aug. 30, 1932:		
6 a. m.	Light SE	12
10 a. m.	do	10
4 p. m.	do	12
Aug. 31, 1932:		
6 a. m.	Moderate SE	8
8 a. m.	Heavy SE	7
11 a. m.	do	6½
Noon	Very heavy SE	6

A chart showing tracks of centers of the three tropical storms discussed in connection with records of swell at Galveston and Santa Rosa Island appears as figure 9.

The observations available show that a fully developed tropical storm in the Gulf of Mexico causes swells that arrive on shore at a rate of about 5 per minute, decreasing in exceptionally severe hurricanes to a rate of 4 per minute. This corresponds with time intervals of 12 to 15 seconds between crests. From these periods, Cornish derives a wave speed of 42 to 52 miles an hour, which he believes to be only a little less than the speed of the wind. By formula a wind velocity of 50 to 60 miles an hour would be indicated. However, tropical storms of the type producing swells in the Gulf of Mexico with periods of 12 seconds are certainly attended by much higher wind velocities. From this it is reasonable to infer that the length of fetch is insufficient to permit the full development of waves corresponding to the actual wind velocities as computed from formula for great lengths of fetch over open ocean.

In connection with extratropical cyclones, long series of observations at coastal points have been recorded by Cornish [2] which show wave periods running regularly between 18 and 24 seconds. It is doubtful if tropical cyclones ever create waves of that magnitude while in the Tropics. If the formulas for wave dimensions in relation to wind velocity are accurate when applied to the winds of the extratropical cyclone, as appears to be the case, then certainly these formulas are not applicable to tropical storms. The writer prefers to judge the intensity of a storm in the Gulf of Mexico by assuming that the force of the wind on the Beaufort scale is the same as or slightly less than the period of the swell in seconds.[7] For example, a period of 10 seconds (6 waves per minute) would indicate a wind force of 9 or 10 (Beaufort); and a period of 13 or more seconds would indicate a full hurricane or force 12 (Beaufort).

CONCLUSION

While there is a large body of observations of sea swells, part of which were connected with tropical storms, much remains to be accomplished in acquiring suitable records for study. This discussion is presented as an indication of the probable value of collecting and studying adequate and systematic series of observations, both under normal weather conditions and when tropical storms are in progress.

The available records appear to show definite relations of storm intensity and movement to the period and direction of swells, as follows:

1. Within the tropical cyclone, the winds turn to the left of the swell in the Northern Hemisphere, to the right in the Southern Hemisphere.

2. The progressive movement of the tropical cyclone results in differences in the amount of deviation of wind from swell in the different parts of the cyclone.

3. In the tropical cyclone, the length of fetch of the winds is insufficient to develop waves of the maximum length and period theoretically possible under favorable conditions with winds of hurricane force acting upon long stretches of deep sea.

4. The period of storm swells is indicative of the intensity of the storm and is not dependent upon the distance between the storm center and the point of observation.

5. There is a line of discontinuity in the movement of swell, along the line of progression to the rear of the storm center.

6. When storm swells move into shallow water along the shore, a turning movement results, so that the direction of swell tends toward the normal to the coast line.

7. Waves do not deviate from the wind in the absence of a cyclonic storm or other unusual weather conditions.

8. As a storm increases in intensity the period of the swell increases.

9. The size of waves caused by winds depends upon the extent of the water surface over which the winds blow. Waves along the southern Atlantic coast of the United States are much larger under average weather conditions than waves during ordinary weather in the Gulf of Mexico.

10. The winds over a considerable part of the storm field to the right of the center of a traveling cyclone (in the Northern Hemisphere) are directed continuously forward, roughly along the line of progression. The progressive movement of the cyclone increases the force of these winds upon the water, hence the largest swells are developed there. They run far ahead of the cyclone.

While there is a considerable body of observational data which unquestionably support the foregoing statements, there is nevertheless a disappointing lack of information regarding some features of hurricane swells, in particular the following:

1. Practically nothing has been done toward charting the character of sea swells that exist during the prevalence of average weather conditions in the southern North Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico. A better knowledge of average conditions is essential for a proper understanding of storm swells.

[7] Tannehill, I. R. Preparation and Use of Weather Maps at Sea, p. 38. Washington, 1935.

2. Systematic observations of sea swells at Coast Guard stations on the southern Atlantic and Gulf coasts of the United States are now being taken daily during the hurricane season. Each situation on the coast, where observations of swell are made, has its own peculiarities, which should be carefully studied to ascertain the effect upon direction of swell and to determine whether the observations in that situation are sufficiently representative of ocean conditions to justify use of the data recorded.

3. Although systematic observations of swell are reported by ships at sea, the elements included in the reports are only direction and general character, but not the period. The direction is sometimes improperly recorded as that toward which the swells are moving rather than the direction from which they come. Cross seas in the storm field make it difficult in some cases to determine the dominant swell; in other cases the waves are so confused that the observations can show only that the sea is very rough.

4. Even on shore in excellent locations for observing sea waves, the storm swells are often confused by local waves so that it is difficult to determine the true direction and period of storm swells. At Galveston, for example, a tropical disturbance in the southwest Gulf of Mexico is likely to cause an increase in force and a change of the prevailing wind at Galveston to easterly, producing local waves of considerable size running across a light storm swell from the southeast or south. Oftentimes in such cases, however, the storm swell is discernible to the experienced observer.

5. When observations of swell on shore and on shipboard have been completely standardized and after adequate records have been accumulated for study, reports of sea swells should prove increasingly valuable in the hurricane warning service. Preliminary studies indicate that the elements of real value are direction and period of swell. The period of swell gives information as to the intensity of storm winds which cannot be obtained with any precision from descriptions of swells in terms of height and length.

6. As to observation of period of swell on shipboard, Cornish [8] stated, as a result of observation during voyages through the Caribbean Sea:

> It has been pointed out that a single observer upon a vessel under way can readily and quickly determine the period of the waves by noting the time taken by a patch of foam in falling and rising. If a swift running, slow heaving swell be present, its period of oscillation can also be determined by the foam spots, for the slower heave is easily watched, not, as might be expected, camouflaged by the shorter waves.

ACKNOWLEDGMENTS

The writer has used data supplied by Mr. Paul Watson of Galveston who has studied sea swells in connection with tropical storms for more than 25 years. Acknowledgment is also made of the assistance of Messrs. Earl C. Thom and Robert B. Evans of the Marine Division, who examined ships' observations and prepared maps from which some of the illustrations in this article were selected.

[8] Encyclopedia Brittanica, 14th edition. Waves of the Sea. Article by Vaughn Cornish, London, 1929.

TROPICAL DISTURBANCES, JULY 1936

By J. H. GALLENNE

[Weather Bureau, Washington, August 1936]

Two well-defined tropical disturbances occurred during July 1936. One crossed the Louisiana coast on the 27th; the other moved from the Atlantic through extreme southern Florida and passed inland east of Pensacola on the 31st. The synoptic weather map, Noon G. M. T., of July 27 is reproduced in chart IX, with the tracks of these two disturbances.

There were two other disturbed conditions originating over tropical waters, one during the period July 12 to 14, in the western Gulf of Mexico, and the other on July 22 near Puerto Rico; but neither appears to have developed more than slight intensity. The available reports do not show definite progressive movements to any considerable distances beyond the areas in which they were first observed.

July 26–28.—From the ships' weather observations taken at 7 a. m., E. S. T., on July 26, it was evident that there was a tropical disturbance in the southeastern portion of the Gulf of Mexico; and by 7 p. m. its position could be fixed, from ship reports, as being near latitude 26° north and longitude 89° west, with relatively slow movement in a northwesterly direction. At that time the disturbance appeared to be of slight intensity and confined to a small area, although there was a fairly definite cyclonic wind circulation. At 5 p. m. the S. S. *Davanger* near 26½° north, 88° west, reported squally weather, wind force 8, barometer 29.82 inches.

This depression moved on a north-northwesterly course during the next 12 hours, being located approximately 60 miles south of the coast of Louisiana, near the 90th meridian, at 8 a. m., E. S. T. of the 27th. At 7 a. m. the S. S. *San Gil*, at 28°15′ north and 89°30′ west, reported south-southeast winds of force 5 (Beaufort scale) with barometer reading 29.76 inches.

During the early afternoon of the 27th, the disturbance moved inland over southern Louisiana. At Delta Farms, Lafourche Parish, the lowest pressure was 29.62 inches (corrected) at 1:30 p. m. E. S. T. This is the lowest barometer reading of record during the progress of the disturbance. It was accompanied by an estimated wind velocity of 50 miles an hour. At the New Orleans Weather Bureau Office, a short distance to the right of the path of the center, the lowest pressure was 29.74 inches, at 5 p. m. on the 27th. Advancing farther inland with a recurve to the northeastward, the disturbance moved into Mississippi and dissipated on July 28.

Storm warnings for the Louisiana coast were issued at 9:15 a. m. E. S. T. on July 27 and all interests were advised to prepare for storm winds and rising tides. The conditions which occurred during the afternoon were fully and accurately heralded in the bulletin disseminated by the forecaster at New Orleans at 12:30 p. m., E. S. T.:

> July 27. Bulletin 12:30 p. m. E. S. T.: Tropical storm is turning northward and will move inland during next few hours over Lafourche and eastern Terrebonne Parishes, La., attended by shifting gales from Grand Isle westward to near Houma, La., with tides considerably above normal in area named.

There was no loss of life, and no important storm damage was reported.

July 27–August 1.—The history of this disturbance is not clearly shown by the observations until the morning of July 27 when a well-formed but weak cyclonic circulation was charted a short distance south of Cat Island, Bahamas. Progressing on a west-northwesterly course, with increasing intensity, the disturbance crossed Andros

Island at 5 a. m. on the 28th. The S. S. *Atenas* passed through a calm area between the hours of 6:15 p. m. and 7:15 p. m., E. S. T., on this date, while in the vicinity of latitude 25° north and longitude 80° west. The lowest barometer reported by this ship was 29.38 inches. At 7 p. m., E. S. T., the S. S. *Tiger*, a short distance from the *Atenas*, reported a barometer reading of 29.48 inches with a northwest gale of force 9 (Beaufort scale), clear weather, heavy rough sea, and squalls. An hour later, this same ship, giving her position as off Molasses Reef, reported clear sky, southwest gale, rising pressure, 29.54 inches.

With estimated wind velocities of 60 miles an hour near its center, the storm reached the southern tip of the Florida mainland about 30 miles south of Miami at 8 p. m. The Weather Bureau Office at Miami reported a maximum wind velocity of 44 miles an hour from the southeast, while the Miami Airport Station gave east-southeast winds of 49 miles an hour with gusts of 65 miles an hour.

Between 9:30 and 10 p. m., E. S. T., the storm center passed over Homestead and Florida City, maintaining a west-northwesterly course, with a progressive movement of about 10 to 12 miles an hour. The center then moved to the Gulf of Mexico; and at 8 a. m., E. S. T., of the 29th was located at approximately 26° north and 82°15′ west.

The following is taken from the report of G. E. Dunn, forecaster at Jacksonville.

* * * The center of the storm passed a short distance south of Everglades City where a barometer reading of 29.51 inches (possibly the barometer fell still lower later) was reported at 2 a. m. with 55 miles northeast wind. Following the passage of the axis of the center an abnormally high tide occurred and by morning the tide was 5.5 feet above mean low and the water was 18 inches deep in the streets of the town at normal low tide. During the forenoon winds of about 60 miles prevailed in the Boca Grande section but with little damage.

At 3:30 p. m. hurricane warnings were ordered north of Cedar Keys to Apalachicola and were later extended westward as the storm made no further recurve. As the storm approached the northwest Florida coast its rate of movement decreased and north of Cedar Keys and especially from St. Marks westward abnormally high tides were produced considering the size and intensity of the disturbance. This was probably due to the slow movement of the storm in this area, giving the wind ample time to pile up the water along the coast. * * *

At 11 o'clock, E. S. T., on the morning of July 31, the storm had crossed the northwest Florida coast and was centered over Valparaiso, a community on the northern shore of Choctawhatchee Bay, situated about 45 miles east of Pensacola. Reports from Valparaiso at 9 a. m. gave a barometer reading of 28.80 inches attended by east-northeast winds, estimated at 90 to 100 miles an hour. The barometric minimun, 28.73 inches, occurred there at 11 a. m., E. S. T. The calm center was over Fort Walton and Valparaiso about 1 hour and 20 minutes.

From the report of R. A. Dyke, forecaster at New Orleans:

* * * The hurricane winds extended on the coast line for about 70 miles but when allowance is made for the angle at which the storm reached the coast, the hurricane winds may be accepted as covering a width of not much over 50 miles directly across the path of the storm. * * *

As the storm moved in, the storm tide reached a height of approximately 6 feet at Panama City and Valparaiso. * * *

With rapidly diminishing intensity, after passing inland, the storm continued to move northwestward, and was centered just north of Pensacola at 8 p. m., E. S. T., of July 31. It dissipated on August 1 over the southwestern portion of Alabama.

The Weather Bureau forecasters at Jacksonville and at New Orleans issued timely warnings and bulletins relative to the intensity and movement of this disturbance. The first advice was disseminated at 9:30 a. m., E. S. T., of July 27 and advisories and bulletins followed at frequent intervals thereafter, until the storm had dissipated. In all sections affected the display of warnings preceded the arrival of the storm by 12 to 24 hours. Reports indicate property damage was slight as the storm crossed the lower portion of Florida. In the vicinity of Valparaiso and in nearby coastal sections, property damage was placed at $123,000, as a result of wind and storm tides. Quoting again from the report of G. E. Dunn:

The fishing boat *Ketchum* was apparently lost in the Gulf with 4 persons aboard but no other loss of life directly attributable to the storm in the Jacksonville district has been reported. Fortunately most of the sponge fleet was in port but the Coast Guard plane at St. Petersburg identified and warned 11 sponge and fishing vessels involving 40 persons and a total value of $22,000 in the storm area. The *Ketchum* left port on the 23d before the first advisory was issued and was outside the area searched by the Coast Guard plane. * * *

DUSTSTORMS OF JULY 1936 IN THE UNITED STATES

By R. J. MARTIN

[Weather Bureau, Washington, August 1936]

July had only a few duststorms, mostly local in character; with one or two exceptions, they were confined to the area between the Mississippi River and the Rocky Mountains. East of the Mississippi there were only a few scattered reports of dusty conditions.

Dense dust was reported locally over the Great Plains from Texas northward to the Canadian border, but the number of occurrences was small—in most States the average for the month was less than two storms, while in several others only light dust was noted. For example, Minnesota reported no dense dust; and only one station, in the extreme western portion of the State, observed light dust. Oklahoma, Kansas, and Nebraska, the Dakotas, Iowa, Montana, and Wyoming were among the States experiencing dense dust during July.

At Havre, Mont., visibility was reduced to about one-half city block for 3 minutes on the 17th; the storm of the 19th at Sioux City, Iowa, reduced visibility to 300 feet for a brief period, and was followed by rain. Automobile lights were necessary at times in Sioux City during this storm; and similar conditions prevailed at Helena, Mont., on the 14th. General rains on the 27th terminated dusty conditions in southeastern counties of Colorado.

Unless the storms of August are more frequent and severe, the next issue of the REVIEW will have no duststorm summary.

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[RICHMOND T. ZOCH, *in Charge of Library*]

By AMY D. PUTNAM

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SOLAR OBSERVATIONS

SOLAR RADIATION OBSERVATIONS DURING JULY 1936

By IRVING F. HAND, *Assistant in Solar Radiation Investigations*

For a description of instruments employed and their exposures, the reader is referred to the January 1935, REVIEW, page 24.

Table 1 shows that solar radiation intensities averaged above normal for July at both Washington and Lincoln, and below normal at Madison. A great deal of haze was noted during most of the observational periods at Madison.

Table 2 shows an excess in the total solar and sky radiation received on a horizontal surface at all stations except Miami, Blue Hill, Riverside, and Friday Harbor—all coastal stations. The excess at some stations was greater than for any previous month.

Table 3 shows high turbidity values at both Washington and Blue Hill, with moderate water-vapor content of the atmosphere considering the season of the year.

Polarization observations taken at Washington on 5 days give a mean of 56 percent with a maximum of 58 percent on the 7th. At Madison, observations made on 12 days give a mean of 50 percent with a maximum of 59 percent on the 7th. The values for Washington are slightly below the July normals, while those for Madison are considerably below the normals for the month.

TABLE 1.—*Solar radiation intensities during July 1936*

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.

Date	Sun's zenith distance										
	8 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass									Local mean solar time
		A. M.					P. M.				
	e	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e
	mm	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm*
July 7	14.60	------	------	------	1.16	1.46	------	------	------	------	10.21
July 8	14.10	------	------	------	1.10	1.35	------	------	------	------	16.20
July 9	17.37	------	------	------	1.04	1.27	------	------	------	------	17.37
July 10	17.96	------	------	------	.84	1.24	------	------	------	------	16.79
July 15	16.79	------	------	0.71	.89	1.18	------	------	------	------	16.79
July 17	15.11	------	------	.72	.81	1.14	------	------	------	------	13.13
July 23	17.37	------	------	.84	.99	1.23	------	------	------	------	14.10
July 25	10.97	------	------	.55	.81	1.23	------	------	------	------	9.14
Means	------	------	------	.70	.96	1.26	------	------	------	------	------
Departures	------	------	------	−.08	+.04	+.05	------	------	------	------	------

[1] Extrapolated.

TABLE 1.—*Solar radiation intensities during July 1936*—Con.

[Gram-calories per minute per square centimeter of normal surface]

MADISON, WIS.

Date	Sun's zenith distance: 8 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	1.0	2.0	3.0	4.0	5.0	e
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm*
July 2	11.81	------	0.84	------	------	1.29	------	------	------	------	11.38
July 6	11.38	------	.62	0.79	0.96	1.29	------	------	------	------	15.65
July 7	16.79	------	.78	.96	1.11	1.40	------	------	------	------	17.37
July 8	16.20	------	.80	.95	1.12	1.36	------	------	------	------	15.65
July 9	15.11	0.60	.71	.86	.98	------	------	------	------	------	16.20
July 10	16.20	------	.74	.90	1.04	1.29	------	------	------	------	17.37
July 13	20.57	.49	.59	.73	.90	1.18	------	------	------	------	18.59
July 14	19.89	------	.52	------	------	------	------	------	------	------	17.37
July 16	12.68	------	.50	.60	.76	1.12	------	------	------	------	14.10
July 18	16.20	------	------	------	------	1.25	------	------	------	------	18.59
July 21	11.38	------	------	------	------	1.38	------	------	------	------	7.57
July 23	14.10	------	------	------	.95	------	------	------	------	------	15.11
July 27	12.68	------	.54	------	------	------	------	------	------	------	16.79
July 28	14.60	.57	.66	------	.98	------	------	------	------	------	11.81
July 29	11.81	.66	.84	------	1.22	------	------	------	------	------	9.87
July 31	9.45	.54	.70	------	1.04	------	------	------	------	------	10.59
Means	------	.57	.68	.83	1.01	1.28	------	------	------	------	------
Departures	------	−.10	−.10	−.09	−.06	−.03	------	------	------	------	------

LINCOLN, NEBR.

July 1	------	------	------	------	------	1.44	1.24	1.06	0.92	0.82	7.38
July 2	------	------	0.94	1.08	1.22	1.45	1.16	.98	.85	.72	6.76
July 6	13.13	0.72	.84	.98	1.20	1.43	------	------	------	------	12.24
July 7	9.47	.75	.85	.98	1.15	1.39	------	------	------	------	11.81
July 9	15.11	.80	.89	1.04	1.22	1.40	------	------	------	------	11.81
July 10	14.60	.72	.82	1.00	1.18	1.42	------	------	------	------	11.81
July 11	14.10	------	.86	1.01	1.17	1.39	------	------	------	------	10.59
July 12	13.13	------	------	------	1.10	1.35	------	------	------	------	13.13
July 15	10.97	.91	1.02	1.16	1.24	1.45	1.18	1.00	.85	.71	9.47
July 16	14.10	.64	.71	.84	1.05	1.39	------	------	------	------	11.38

TABLE 1.—*Solar radiation intensities during July 1936*—Con.

[Gram-calories per minute per square centimeter of normal surface]

LINCOLN, NEBR.—Continued

Date	Sun's zenith distance: 8 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	1.0	2.0	3.0	4.0	5.0	e
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm*
July 17	9.14	------	------	0.84	1.02	1.30	------	------	------	------	10.21
July 23	10.21	0.67	0.79	1.01	1.18	1.46	------	------	------	------	8.18
July 24	11.38	------	.88	1.06	1.33	------	------	------	------	------	9.14
July 31	12.24	.80	.90	1.03	1.17	1.34	------	------	------	------	6.27
Means	9.14	.75	.87	.99	1.15	1.40	1.18	1.00	0.85	0.71	------
Departures	6.27	+.04	+.08	+.07	+.07	+.06	+.11	+.11	+.09	+.01	------

BLUE HILL OBSERVATORY OF HARVARD UNIVERSITY

July 1	6.8	------	0.99	1.10	1.22	1.44	1.13	0.91	0.76	0.69	7.1
July 2	11.5	------	------	------	1.11	1.27	.75	------	------	------	10.5
July 4	13.7	------	------	------	------	1.20	.83	------	------	------	11.5
July 6	12.8	------	------	------	------	1.32	1.06	------	------	------	11.9
July 7	13.7	------	.82	1.09	1.29	1.34	------	------	------	------	8.6
July 8	11.5	------	------	------	------	1.17	.83	.55	------	------	12.3
July 9	15.8	------	------	------	------	1.18	------	------	------	------	16.9
July 10	17.5	------	------	------	------	1.23	------	------	------	------	17.5
July 15	11.1	------	------	------	1.16	1.20	------	------	------	------	10.3
July 16	9.6	------	------	------	1.20	1.40	------	------	------	------	9.9
July 17	10.7	------	------	------	1.17	1.21	------	------	------	------	10.7
July 19	12.8	------	------	------	------	1.19	------	------	------	------	12.3
July 22	11.9	------	------	------	------	1.05	.65	------	------	------	13.2
July 23	12.8	------	------	------	.75	.87	------	------	------	------	15.3
July 25	9.9	------	------	------	1.22	------	------	------	------	------	9.2
July 26	8.6	------	------	------	1.16	1.46	------	------	------	------	8.6
July 27	9.6	------	------	------	------	1.35	1.11	------	------	------	9.6
July 28	13.2	------	------	------	1.19	1.23	------	------	------	------	11.5
Means	------	------	.90	1.10	1.15	1.24	.91	.73	.76	.69	------

TABLE 2.—*Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface*

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Pittsburgh	Fairbanks	Twin Falls	La Jolla	Miami	New Orleans	Riverside	Blue Hill	Mount Washington	Friday Harbor	Ithaca	San Juan
	Gram-calories per square centimeter																	
1936	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
July 2	514	597	716	550	570	698	610	408	599	527	496	524	608	588	----------	493	582	633
July 9	563	548	713	527	549	681	585	396	555	540	432	454	596	458	----------	516	576	592
July 16	500	528	670	518	486	696	597	446	568	631	478	642	488	491	----------	720	496	583
July 23	518	553	578	512	414	682	489	393	560	402	495	535	502	514	----------	665	493	555
	Departures from weekly normals																	
July 2	+1	+68	+127	+85	+116	−6	--------	−38	−4	--------	−19	+122	−6	+33	----------	−83	+30	--------
July 9	+67	+13	+127	+68	+95	−17	--------	+103	−46	--------	−90	+60	−7	−68	----------	−60	+30	--------
July 16	+16	+9	+87	+58	−40	+9	--------	+186	−38	--------	−35	+230	−92	−18	----------	+110	−30	--------
July 23	+30	+44	+23	+49	−111	+18	--------	+55	−11	--------	−36	+171	−70	+9	----------	+4	+27	--------
	Accumulated departures on July 29																	
	+2,989	+3,108	+5,992	+9,765	+5,110	+2,965	--------	+2,590	−896	--------	−5,782	+14,383	+21	−812	----------	−371	+889	--------

TABLE 3.—*Total, I_m and screened, I_y, I_r, solar radiation intensity measurements, obtained during July 1936, and determinations of the atmospheric turbidity factor, β, and water-vapor content, w=depth in millimeters, if precipitated*

AMERICAN UNIVERSITY, WASHINGTON, D. C.

Date and hour angle	Solar altitude	Air mass	I_m	I_y	I_r	$\beta_{I_{m-r}}$	$\beta_{I_{y-r}}$	β_{m-y}	$\frac{I_{m-r}}{1.94}$ Percentage of solar constant	$\frac{I_{m-r}-I_m}{1.94}$ Percentage of solar constant	w	Air-mass type
July 8	° ′	*m*	*gr. cal.*	*gr. cal.*	*gr. cal.*						*mm*	
1:40 a. m.	63 05	1.12	1.296	0.886	0.696	0.088	0.056	0.072	82.2	13.2	35.0	N_{PC}→T_M
1:36 a. m.	63 45	1.11	1.300	.886	.696	.086	.056	.071	82.3	13.1	34.0	
July 9												
2:52 a. m.	49 55	1.30	1.106	.802	.637	.156	.096	.126	68.9	10.4	14.0	T_M+S
2:44 a. m.	51 26	1.28	1.110	.802	.637	.156	.096	.126	68.9	10.4	14.0	
July 17												
1:08 a. m.	67 02	1.09	1.080	.738	.582	.158	.148	.153	69.1	11.6	31.0	P_C
1:00 a. m.	68 05	1.08	1.083	.739	.582	.157	.147	.152	69.2	11.6	31.5	

Atmospheric conditions during turbidity measurements

July 8. Temperature 19° C., wind, SW 10; visibility, 30 miles; polarization, 55.2 percent.
July 9. Temperature 20° C.; wind, SW 9; visibility, 20 miles; polarization, 53.3 percent.
July 17. Temperature 30° C., wind, S 6; visibility, 20 miles; polarization, 56.0 percent.

BLUE HILL METEOROLOGICAL OBSERVATORY OF HARVARD UNIVERSITY

July 1												
4:19 a. m.	32 42	1.80	1.253	0.837	0.647	0.036	0.049	0.042	78.6	11.8	8.8	P_c
2:25 a. m.	32 39	1.25	1.375	.860	.691	.037	.037	.037	83.7	10.4	9.1	
2:34 p. m.	52 50	1.25	1.296	.810	.649	.059	.065	.062	79.8	10.7	9.3	
July 2												
2:42 a.m.	51 22	1.28	1.223	.782	.621	.074	.092	.083	75.8	10.6	9.0	N_{PC}→T_N
1:52 a. m.	60 51	1.14	1.246	.789	.633	.070	.048	.059	80.6	14.3	13.0	
July 4												
3:40 p. m.	40 44	1.53	.951	.654	.527	.171	.161	.166	58.7	8.0	6.4	P_c
5:13 p. m.	23 07	2.54	.700	.500	.423	.160	.180	.170	64.4	16.8	10.7	
July 6												
1:17 p. m.	64 43	1.10	1.279	.823	.666	.081	.123	.102	75.6	6.5	6.0	P_c
3:56 p. m.	37 39	1.63	1.154	.760	.617	.060	.080	.070	73.9	12.4	9.6	
July 7												
5:31 a. m.	16 45	3.45	.960	.622	.537	.044	.052	.048	63.6	2.5	1.9	N_{PC}→T_N
3:17 a. m.	44 56	1.41	1.270	.806	.650	.063	.092	.078	70.7	3.0	2.3	
1:47 a. m.	60 55	1.14	1.331	.830	.656	.043	.075	.059	81.7	10.8	9.2	
1:39 p. m.	62 10	1.13	1.267	.805	.643	.082	.095	.088	77.8	10.3	9.1	
July 8												
0:23 p. m.	69 41	1.06	1.153	.721	.582	.114	.200	.157	70.7	9.3	8.8	N_{PC}→T_N
5:52 p. m.	16 15	3.55	.470	.319	.235	.168	.099	.134	41.7	16.6	8.7	
July 9												
0:25 a. m.	69 31	1.06	1.149	.715	.572	.115	.187	.151	72.6	11.6	11.4	T_m+S
July 10												
1:24 p. m.	63 25	1.12	1.226	.755	.620	.191	.200	.196	65.7	.4	.4	N_{PC}, T_m aloft
3:59 p. m.	36 50	1.67	.798	.551	.453	.188	.187	.188	55.5	13.2	10.3	
July 15												
4:40 a. m.	28 49	2.07	1.138	.751	.594	.037	.045	.041	75.4	14.8	13.2	P_c
3:23 p. m.	43 01	1.46	1.184	.766	.623	.059	.081	.070	74.9	11.9	11.0	
July 16												
4:49 a. m.	27 03	2.20	1.116	.745	.578	.038	.031	.034	75.9	16.5	11.0	P_c
2:11 a. m.	55 23	1.21	1.356	.839	.666	.032	.050	.041	84.2	12.0	11.0	
July 17												
4:24 a. m.	29 44	2.01	1.167	.764	.612	.039	.058	.048	74.6	12.5	8.5	P_c
2:36 a. m.	51 34	1.27	1.250	.789	.626	.052	.053	.058	81.0	14.5	12.4	
July 19												
2:21 p. m.	62 00	1.13	1.098	.710	.573	.149	.195	.172	68.5	10.0	8.7	N_{PC}
July 22												
3:03 p. m.	45 47	1.39	.888	.583	.493	(1)	(1)	(1)				N_{PA}
3:34 p. m.	40 13	1.55	.831	.577	.472	.182	.218	.200	57.0	12.4	9.9	
July 23												
3:26 a. m.	41 33	1.51	.815	.562	.468	(1)	(1)	(1)				N_{PC}
2:54 a. m.	48 18	1.36	.840	.581	.474	(1)	(1)	(1)				
July 25												
4:22 a. m.	42 02	1.49	1.234	.782	.633	.079	.081	.080	78.2	12.6	10.1	P_c
4:31 a. m.	46 15	1.38	1.228	.770	.635	.075	.113	.094	72.8	7.5	6.2	
July 26												
3:15 a. m.	43 05	1.46	1.353	.816	.657	.015	.092	.054	78.4	6.5	5.3	P_c
2:58 a. m.	46 11	1.39	1.365	.824	.669	.025	.104	.064	78.4	5.8	4.8	
July 27												
0:43 p. m.	65 15	1.10	1.330	.814	.665	.051	.130	.090	78.1	7.3	6.7	P_c
3:02 p. m.	45 20	1.40	1.245	.772	.615	.045	.099	.072	76.5	9.9	8.2	
4:15 p. m.	32 02	1.88	1.109	.706	.564	.050	.090	.070	70.4	11.2	8.7	
July 28												
3:27 a. m.	40 42	1.53	1.177	.750	.602	.076	.104	.090	73.4	10.9	8.6	N_{PC}
2:58 a. m.	45 15	1.40	1.240	.786	.632	.087	.111	.099	72.5	6.4	5.2	
1:04 p. m.	63 30	1.11	1.222	.770	.624	.095	.175	.135	72.9	7.4	6.8	

[1] On account of film forming on screens during warm and damp weather, all screened readings (I_y & I_r) were found to be 3 percent low, and have therefore been increased by that amount before using them to compute β.

* Turbidity above 0.200 at time these observations were obtained.

Atmospheric conditions during solar radiation measurements, Blue Hill Observatory of Harvard University, July 1936

Date	Time from apparent noon	Air temperature	Wind (Beaufort scale)	Visibility (0-10 scale)	Sky blueness	Cloudiness and remarks
		°C.				
1	2:43 a. m.	+17.8	NW 4	9	7	3 Ci.
2	2:13 a. m.	+23.4	NE 2	8	8	2 Ci, 1 Cicu, mod. haze, wind variable.
2	4:32 p. m.	+21.8	E 2	8	7	5 Ci, 2 Cu, mod. haze, thin ci near sun.
6	2:55 p. m.	+19.6	NE 2	9	8	Few Acu, few Cu.
7	3:35 a. m.	+22.2	W 2	9	8	1 Ci.
7	0:30 a. m.	+26.7	WNW 3	9	8	4 Ci, few Cu.
8	0:28 p. m.	+30.6	W 3	8	7	7 Ci, light haze.
8	0:52 p. m.	+31.1	W 4	8	7	7 Ci, few Acu, few Cu, light haze, Ci near sun.
10	1:40 p. m.	+28.9	W 1	5	5	1 Ci, 1 Cunb, mod. haze.
10	1:57 p. m.	+29.9	WNW 1	5	5	1 Ci, 2 Cunb, mod. haze.
15	4:34 a. m.	+19.2	NW 2	8	7	Few Ci.
16	4:43 a. m.	+17.1	NW 3	9	7	3 Ci, Ci near sun.
16	2:06 a. m.	+20.6	NW 3	9	8	3 Ci, 1 Cu.
17	4:28 a. m.	+17.8	NW 2	7	8	1 Ci, few Acu, light haze.
23	3:13 a. m.	+21.2	SW 4	8	7	Few Ci, few Cu, light haze.
25	4:19 a. m.	+16.9	NW 3	8	7	Few Acu, few Cu.
26	3:11 a. m.	+16.7	W 3	9	8	1 Ci, few Cu.
27	0:25 p. m.	+21.8	W 4	9	6	1 Cu, light haze.
27	3:53 p. m.	+22.8	W 4	9	6	1 Ci, few Cu, light haze.
28	3:17 a. m.	+22.8	SW 3	7	6	1 Ci, mod. haze.

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy (Ret.), Superintendent U. S. Naval Observatory. Data furnished by the U. S. Naval Observatory in cooperation with Harvard and Mount Wilson Observatories. The difference in longitude is measured from the central meridian, positive west. The north latitude is positive. Areas are corrected for foreshortening and are expressed in millionths of the sun's visible hemisphere. The total area for each day includes spots and groups]

Date	Eastern standard time	Heliographic			Area		Total area for each day	Observatory
		Diff. in longitude	Longitude	Latitude	Spot	Group		
1936	h. m.	°	°	°				
July 1	12 5	−65.0	66.5	+32.0		13		Mount Wilson.
		−58.0	73.5	+21.0		26		
		−57.0	74.5	+29.0	18			
		−5.0	126.5	+29.0	4			
		+17.0	148.5	−18.0		2		
		+25.0	156.5	+15.0		12		
		+53.0	184.5	−19.0		177		
		+75.0	206.5	+29.0		195		
		+76.0	207.5	+19.0		563	1,010	
July 2	12 14	−50.0	68.2	+31.0		46		U. S. Naval.
		−44.0	74.2	+21.0		69		
		+37.0	155.2	+14.0		123		
		+39.0	157.2	−19.0		31		
		+60.0	178.2	−20.0		93	362	
July 3	13 30	−29.0	75.3	+20.0		123		Do.
		+52.0	156.3	+14.0		216		
		+75.0	179.3	−20.0	31		370	
July 4	11 1	−18.0	74.4	+20.0		123		Do.
		+35.0	127.4	+29.0		77		
		+65.0	157.4	+13.5		216	416	
July 5	12 18	−4.0	74.5	+19.0		62		Do.
		+10.0	88.5	−16.0		93	155	
July 6	11 43	+8.0	73.5	+18.5		123		Do.
		+23.0	88.5	−16.5		247	370	
July 7	11 4	+36.0	88.7	−16.5		278	278	Do.
July 8	11 5	−79.0	320.4	+21.0		123		Do.
		−36.0	3.4	−27.5		46		
		+49.0	88.4	−16.5		432	601	
July 9	11 20	−65.0	321.0	+21.5		247		Do.
		+45.0	71.0	−28.0		62		
		+63.0	89.0	−16.5		278	587	
July 10	11 6	−61.0	311.9	−14.0		93		Do.
		−52.0	320.9	+21.5		370		
		+74.0	86.9	−16.5		154	617	
July 11	11 7	−83.0	276.7	+20.5	31			Do.
		−47.0	312.7	−14.0		463		
		−38.0	321.7	+21.5		62	556	

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Heliographic			Area		Total area for each day	Observatory
		Diff. in longitude	Longitude	Latitude	Spot	Group		
	h. m.	°	°	°				
July 12	11 31	−70.0	276.2	+20.0	31			U. S. Naval.
		−37.0	309.2	−16.0	23			
		−29.0	317.2	−16.0	31			
		−25.0	321.2	+21.5		494		
		−22.0	324.2	−17.0		123	702	
July 13	12 45	−55.0	277.3	+20.5	39			Mount Wilson.
		−16.0	316.3	−14.0		12		
		−11.0	321.3	+20.5		384		
		−6.0	326.3	−16.0		43		
		+33.0	5.3	−17.0	3		481	
July 14	11 23	−58.0	261.8	+20.0		31		U. S. Naval.
		−43.0	276.8	+20.0	31			
		+1.0	320.8	+21.0		525		
		+6.0	325.8	−17.0		123	710	
July 15	11 9	−43.0	263.7	+19.5		46		Do.
		−30.0	276.7	+20.0	46			
		+14.0	320.7	+20.0		617		
		+17.0	323.7	−19.0	15			
		+22.5	329.2	−14.0	15		739	
July 16	10 55	−71.0	222.6	−19.0	93			Do.
		−27.0	266.6	+19.5	31			
		−17.0	276.6	+20.0	31			
		+26.5	320.1	+20.0		617	772	
July 17	11 3	−59.0	221.3	−19.0		185		Do.
		−18.0	262.3	+19.5	15			
		−9.0	271.3	+17.0		93		
		−4.0	276.3	+20.0	31			
		+40.0	320.3	+20.0		370	694	
July 18	8 30	−48.0	220.5	−18.0	239			Mount Wilson.
		−5.0	263.5	+20.0		3		
		+3.0	271.5	+15.0	15			
		+7.0	275.5	+20.0	9			
		+14.0	282.5	+23.0	8			
		+47.0	315.5	−25.0		10		
		+54.0	322.5	+20.0		298	582	
July 19	11 6	−33.0	220.8	−19.0		185		U. S. Naval.
		+60.9	313.8	+23.0	15			
		+71.0	324.8	+19.0		170	370	
July 20	13 5	−78.0	161.6	+12.0	79			Mount Wilson.
		−18.0	221.6	−18.0		171		
		+22.0	261.6	+20.0		12		
		+88.0	327.6	+19.0	114		376	
July 21	11 38	−66.0	161.1	+11.0	31			U. S. Naval.
		−6.0	221.1	−19.0		185	216	
July 22	11 37	−52.0	161.9	+11.0	46			Do.
		+7.5	221.4	−18.5		154	200	
July 23	11 10	−40.0	160.9	+11.0	46			Do.
		+8.0	208.9	+23.0		31		
		+20.0	220.9	−18.5		123	200	
July 24	15 10	−24.0	161.5	+11.0	62			Do.
		+23.0	208.5	+24.0		93		
		+33.0	218.5	+24.0	15			
		+35.0	220.5	−17.5		123	293	
July 25	11 6	−13.0	161.5	+11.0	46			Do.
		+35.0	209.5	+22.5		154		
		+48.0	222.5	−18.0	123		323	
July 27	13 34	+14.5	161.2	+11.0	31			Do.
		+62.0	208.7	+21.0		123	154	
July 28	13 12	−68.0	65.6	−28.0		278		Do.
		+27.0	160.6	+11.0	15			
		+76.0	209.6	+21.5		93	386	
July 29	11 32	−55.0	66.3	−27.0		309		Do.
		−27.0	94.3	+26.5		154	463	
July 30	12 0	−49.0	58.8	−25.0		48		Mount Wilson.
		−40.0	67.8	−22.0		68		
		−40.0	67.8	−26.0		316		
		−13.0	94.8	+26.0		259		
		+6.0	113.8	−26.0		7		
		+20.0	127.8	−21.0	4			
		+30.0	137.8	−10.0	2			
		+64.0	171.8	+28.0		42	745	
July 31	13 58	−35.0	58.5	−26.0		154		U. S. Naval.
		−28.0	65.5	−26.0	216			
		−26.0	67.5	−19.0		123		
		0.0	93.5	+26.0		370		
		+43.0	136.5	−10.0	46			
		+78.0	171.5	+28.0		62	971	

Mean daily area for 30 days, 490

PROVISIONAL SUN-SPOT RELATIVE NUMBERS, JULY 1936

(NOTE.—The above report not received in time for inclusion in this issue.—ED.)

AEROLOGICAL OBSERVATIONS

[Aerological Division, D. M. LITTLE in charge]

By L. T. SAMUELS

In view of the fact that airplane observations were begun at a number of stations on July 1, 1934, so that a 3-year period has been completed, the departures from the "normals" thus determined have been included in table 1. The total number of observations represented by the normals for each station is indicated at the bottom of the table.

The free-air temperatures for July averaged above normal in most cases, except along the Atlantic coast and the Great Lakes region where the departures were negative. Temperature departures were of small to moderate magnitude at all stations. The lowest mean temperature for the month occurred at Selfridge Field at the 5-km level.

Free-air relative humidity departures for the month were of small to moderate magnitude in all cases, and mostly negative except at San Diego and Boston where they were positive at all levels. The free-air relative humidities in general averaged lower at the northern than at the southern stations with certain exceptions, viz., at Billings the average relative humidity increased in the higher levels to a mean of 60 percent at 5 km. The relative humidity also averaged comparatively high in the upper levels at Pensacola, El Paso, and Mitchel Field. The free-air relative humidity averaged lowest for the month at Selfridge Field.

A comparison of the free-air resultant winds for the month with the corresponding normals reveals a greater northerly component than normal over the Great Lakes region, Ohio Valley, and middle Atlantic coast. In most of these cases the resultant velocities were above normal in the lower levels, and below normal in the upper levels.

The resultant wind movement for the month showed in general a southerly drift west of the Mississippi River, and a northerly drift elsewhere. Resultant directions, except as noted above, were in general close to normal.

Resultant velocities in the lower levels averaged above normal over most stations, except over the Great Plains States where the departures were mostly negative. At the higher levels negative departures occurred over most of the country, except the Pacific coast and New England where they were positive. No large departures in resultant velocities occurred at any of the stations.

TABLE 1.—*Mean free-air temperatures and relative humidities obtained by airplanes during July 1936*

TEMPERATURE (° C.)

Stations	Altitude (meters) m. s. l.																Number of observations
	Surface		500		1,000		1,500		2,000		2,500		3,000		4,000		5,000		
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	
Barksdale Field (Shreveport), La.[1] (52 m)	24.2		25.1		22.8		19.9		17.3		14.3		11.2		4.7		−1.3		31
Billings, Mont.[2] (1,088 m)	22.2	+2.6					24.5	+2.5	21.8	+1.9	18.2	+1.6	14.4	+1.2	6.6	+1.0	−1.3	+1.1	31
Boston, Mass.[1] (5 m)	16.3		17.3		14.4		11.4		9.0		7.0		4.8		−0.1		−5.1		7
Cheyenne, Wyo.[2] (1,873 m)	16.3	+0.4							18.8	+0.6	19.5	+0.3	16.0	+0.3	7.8	+0.6	−0.6	+0.9	31
El Paso, Tex.[2] (1,194 m)	23.6						23.3		20.3		16.6		12.8		5.0		−1.8		31
Fargo, N. Dak.[2] (274 m)	21.0	+2.4	25.5	+3.6	23.9	+2.1	21.2	+1.7	17.9	+1.2	14.2	+0.7	10.6	+0.5	3.6	+0.5	−3.6	+0.4	31
Kelly Field (San Antonio), Tex.[1] (206 m)	23.3	−0.2	23.4	−0.4	21.8	−0.4	19.3	−0.5	17.1	+0.1	14.4	+0.4	11.5	+0.5	5.0	+0.3	−1.8	−0.2	28
Lakehurst, N. J.[3] (39 m)	19.2		20.7		18.6		16.1		13.2		10.5		8.3		2.9		−1.3		26
Maxwell Field (Montgomery), Ala.[1] (52 m)	24.5	+0.2	24.7	0.0	22.6	+0.3	19.5	+0.5	16.6	+0.6	13.7	+0.5	11.0	+0.7	4.5	+0.3	−1.8	0.0	30
Mitchel Field (Hempstead, L. I.), N. Y.[1] (29 m)	18.6	−1.3	20.1	−1.0	19.2	0.0	16.4	+0.2	13.3	+0.1	10.4	−0.1	7.7	−0.1	2.0	0.0	−4.7	−0.7	29
Murfreesboro, Tenn.[2] (174 m)	22.9	+0.4	24.2	0.0	23.1	+0.7	20.5	+1.0	18.0	+1.3	14.9	+1.1	11.7	+1.1	5.3	+0.9	−0.6	+1.1	30
Norfolk, Va.[3] (10 m)	23.4	−1.1	23.9	+0.2	21.4	−0.2	18.3	−0.6	14.7	−1.0	11.6	−1.3	8.6	−1.5	1.7	−2.3	−4.3	−2.5	24
Oklahoma City, Okla.[2] (391 m)	24.7	+0.5	26.4	+0.6	25.5	−0.3	22.7	0.0	19.0	−0.1	15.4	−0.3	11.8	−0.3	5.1	−0.1	−1.3	−0.2	31
Omaha, Nebr.[2] (300 m)	25.0	+1.9	27.9	+2.8	27.9	+2.0	24.6	+1.6	21.1	+1.3	17.2	+1.1	13.4	+1.0	6.1	+1.1	−1.3	+0.8	31
Pensacola, Fla.[3] (13 m)	24.2	−1.4	24.2	0.0	21.5	0.0	18.4	0.0	15.5	+0.2	12.4	+0.1	9.9	+0.5	3.3	0.0	−2.6	−0.1	30
San Diego, Calif.[3] (10 m)	20.3	−0.2	19.8	+1.3	23.5	+1.2	23.4	+1.0	20.7	−0.4	17.4	−1.4	13.0	−3.1	6.3	−2.8	−1.3	−3.2	30
Scott Field (Belleville), Ill.[1] (135 m)	23.2	+0.8	26.5	+0.3	25.7	+1.0	22.8	+1.2	19.1	+0.9	15.7	+0.8	12.2	+0.8	5.3	+1.1	−1.3	+0.8	28
Seattle, Wash.[3] (10 m)	14.0	−1.9	12.2	−1.3	10.9	−1.5	8.9	−1.7	8.2	−0.7	6.5	−0.3	4.9	+0.3	−1.2	−0.1			11
Selfridge Field (Mount Clemens), Mich.[1] (177 m)	17.2	−1.7	21.1	−0.7	19.5	−0.6	16.1	−0.8	12.6	−1.2	9.2	−1.6	6.4	−1.6	0.0	−1.8	−6.5	−2.1	31
Spokane, Wash.[2] (596 m)	15.6	+0.4			21.7	+2.0	21.2	+2.8	18.0	+3.1	14.5	+3.4	11.3	+3.6	4.5	+3.5	−2.6	+3.5	31
Washington, D. C.[3] (13 m)	20.9	−2.8	22.5	+0.1	20.2	−0.2	17.1	−0.5	13.9	−0.8	10.8	−1.0	8.0	−1.0	1.9	−1.4	−3.3	−0.9	29
Wright Field (Dayton), Ohio[1] (244 m)	20.9	+0.3	23.0	+0.2	23.1	+0.6	20.3	+0.8	17.2	+0.8	13.9	+0.6	10.6	+0.3	4.6	+0.3	−1.1	+0.6	31

Observations taken about 4:00 a. m., 75th meridian time, except along the Pacific coast and Hawaii where they are taken at dawn.
[1] Army.
[2] Weather Bureau.
[3] Navy.

TABLE 1.—*Mean free-air temperatures and relative humidities obtained by airplanes during July 1936*—Continued

RELATIVE HUMIDITY (PERCENT)

Stations	Altitude (meters) m. s. l.																		Number of observations
	Surface		500		1,000		1,500		2,000		2,500		3,000		4,000		5,000		
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	
Barksdale Field (Shreveport), La.	86	.....	71	.....	66	.....	63	.....	59	.....	57	.....	57	.....	62	.....	56	.....	.....
Billings, Mont.	44	−8	.....	.....	.....	.....	33	−9	33	−7	36	−6	40	−3	48	+2	60	+8	.....
Boston, Mass.	76	.....	54	.....	53	.....	53	.....	49	.....	42	.....	45	.....	40	.....	40	.....	.....
Cheyenne, Wyo.	61	0	.....	.....	.....	.....	.....	.....	54	−1	42	−1	43	+1	48	+1	56	+1	.....
El Paso, Tex.	54	.....	.....	.....	.....	.....	58	.....	59	.....	61	.....	65	.....	70	.....	68	.....	.....
Fargo, N. Dak.	62	−15	46	−15	41	−10	39	−8	40	−4	43	0	45	+1	49	+4	53	+6	.....
Kelly Field (San Antonio), Tex.	95	+3	92	+5	79	+5	73	+5	63	−1	57	−2	53	−2	53	+2	53	+2	.....
Lakehurst, N. J.	87	.....	61	.....	53	.....	58	.....	61	.....	58	.....	46	.....	46	.....	38	.....	.....
Maxwell Field (Montgomery), Ala.	86	−2	74	+1	70	−1	69	−4	65	−5	59	−5	56	−6	56	−5	54	−2	.....
Mitchel Field (Hempstead, L. I.), N. Y.	92	+1	80	+5	70	0	69	−1	73	+3	73	+7	69	+7	61	+3	62	+6	.....
Murfreesboro, Tenn.	87	−3	69	−2	64	−5	63	−6	58	−7	55	−5	54	−4	52	0	49	0	.....
Norfolk, Va.	88	+7	66	−6	64	−3	61	−5	62	−1	60	0	57	+1	58	+3	52	+4	.....
Oklahoma City, Okla.	65	−6	62	−2	56	+2	53	0	53	0	53	+1	55	+4	53	+2	49	+1	.....
Omaha, Nebr.	55	−16	47	−14	39	−9	39	−7	39	−6	41	−5	43	−4	43	−4	42	−3	.....
Pensacola, Fla.	92	+5	80	0	76	0	75	+1	71	0	67	−1	60	−5	62	−2	62	+3	.....
San Diego, Calif.	86	+6	82	+1	55	+4	43	+3	41	+8	42	+7	45	+7	52	+9	55	+10	.....
Scott Field (Belleville), Ill.	75	−8	57	−4	48	−10	48	−10	51	−7	50	−5	50	−4	47	−6	46	−4	.....
Seattle, Wash.	84	+7	78	+1	72	0	70	+3	57	−4	44	−10	35	−13	27	−18	.....	.....	.....
Selfridge Field (Mount Clemens), Mich.	79	−1	54	−5	48	−8	48	−9	49	−9	46	−7	41	−7	34	−9	32	−6	.....
Spokane, Wash.	61	0	.....	.....	52	+4	48	+3	48	+1	49	−1	52	+1	54	+3	50	0	.....
Washington, D. C.	87	+11	49	−17	48	−14	52	−11	56	−7	56	−5	52	−6	49	−3	44	−3	.....
Wright Field (Dayton), Ohio	75	−8	66	−3	61	0	64	+1	64	+4	63	+6	63	+8	54	+5	51	+6	.....

NOTE.—The departures are based on "normals" covering the following total number of observations made during the same month in previous years, including the current month: Billings, 93; Cheyenne, 92; Fargo, 93; Kelly Field, 90; Maxwell Field, 85; Mitchel Field, 71; Murfreesboro, 92; Norfolk, 173; Oklahoma City, 92; Omaha, 121; Pensacola, 210; San Diego, 196; Scott Field, 89; Seattle, 67; Selfridge Field, 89; Spokane, 92; Washington, 251; Wright Field, 92.

TABLE 2.—*Free-air resultant winds (meters per second) based on pilot-balloon observations made near 5 a. m. (E. S. T.) during July 1936*

[Wind from N=360°, E=90°, etc.]

Altitude (m) m. s. l.	Albuquerque, N. Mex. (1,554 m)		Atlanta, Ga. (309 m)		Billings, Mont. (1,088 m)		Boston, Mass. (15 m)		Cheyenne, Wyo. (1,873 m)		Chicago, Ill. (192 m)		Cincinnati, Ohio (163 m)		Detroit, Mich. (204 m)		Fargo, N. Dak. (274 m)		Houston, Tex. (21 m)		Key West, Fla. (11 m)		Medford, Oreg. (410 m)		Murfreesboro, Tenn. (180 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	354	2.3	255	2.1	282	2.1	298	1.4	288	2.6	344	0.1	115	0.3	318	1.2	148	2.2	141	0.5	127	2.6	294	0.9	203	1.2
500	.....	.....	273	5.0	.....	.....	309	5.2	.....	.....	137	0.5	255	2.1	341	2.0	165	5.0	187	6.6	124	5.6	287	1.6	258	3.1
1,000	.....	.....	285	6.5	.....	.....	295	5.6	.....	.....	269	2.0	299	4.3	324	3.1	198	3.9	188	6.4	122	5.1	288	1.9	272	3.5
1,500	.....	.....	282	4.5	247	1.1	291	6.3	.....	.....	287	4.7	308	6.2	305	4.4	252	2.6	182	5.4	115	4.3	329	0.3	288	3.0
2,000	138	1.9	271	3.7	237	2.0	291	9.2	283	3.5	299	6.1	317	7.2	308	6.4	265	3.8	163	3.4	112	3.5	221	0.6	293	2.5
2,500	169	2.9	270	2.6	243	2.6	288	10.5	250	2.9	308	6.6	326	8.0	311	8.8	293	6.3	146	2.7	119	3.3	202	5.6	311	2.4
3,000	175	2.6	247	2.6	235	4.5	283	12.4	235	2.6	310	7.3	327	7.6	311	9.9	306	7.0	140	1.9	133	2.2	204	8.6	358	2.3
4,000	123	1.0	225	1.2	249	6.0	284	12.4	234	2.0	302	6.7	300	4.4	311	11.5	296	7.9	79	1.6	295	2.3	213	10.9	.....	.....
5,000	81	4.3	18	0.1	262	8.5	.....	.....	248	1.1	299	6.0	54	4.9	314	12.6	.....	.....	159	2.2	.....	.....	216	14.0	.....	.....

Altitude (m) m. s. l.	Newark, N. J. (14 m)		Oakland, Calif. (8 m)		Oklahoma City, Okla. (402 m)		Omaha, Nebr. (306 m)		Pearl Harbor, Territory of Hawaii[1] (68 m)		Pensacola, Fla.[1] (24 m)		St. Louis, Mo. (170 m)		Salt Lake City, Utah (1,294 m)		San Diego, Calif. (15 m)		Sault Ste. Marie, Mich. (198 m)		Seattle, Wash. (14 m)		Spokane, Wash. (603 m)		Washington, D. C. (10 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	328	1.3	338	0.5	187	3.2	176	1.5	.....	.....	253	1.8	248	1.0	143	4.4	355	1.0	6	0.3	111	0.7	106	1.7	315	1.0
500	318	5.0	243	2.5	196	5.8	198	6.2	.....	.....	255	4.0	268	3.9	.....	.....	359	1.0	334	1.4	67	1.3	.....	.....	310	4.6
1,000	321	5.1	284	3.6	215	9.1	224	9.3	.....	.....	257	4.3	296	4.0	.....	.....	347	3.4	306	4.2	228	1.2	213	2.9	312	5.1
1,500	299	5.9	244	2.2	193	3.5	239	7.6	.....	.....	247	3.2	287	3.2	157	6.1	326	3.5	308	5.4	246	2.1	226	4.6	311	5.8
2,000	287	8.2	217	3.4	150	1.8	246	6.1	.....	.....	240	2.8	293	2.5	171	5.2	305	0.7	312	7.0	240	3.7	217	6.0	301	6.3
2,500	281	9.2	222	4.0	108	2.3	265	3.8	.....	.....	222	2.8	309	2.6	191	3.8	147	1.8	315	7.4	232	4.6	224	7.3	304	7.0
3,000	280	10.2	215	3.7	103	2.9	277	3.3	.....	.....	214	2.2	315	2.7	217	3.5	142	3.6	310	8.1	234	5.4	231	8.9	297	7.5
4,000	296	10.7	.....	.....	113	4.7	320	4.3	.....	.....	201	2.3	288	2.5	226	3.8	132	6.8	329	9.2	231	10.4	226	12.3	304	5.5
5,000	.....	.....	.....	.....	.....	.....	280	2.9	.....	.....	.....	.....	.....	.....	214	5.1	.....	.....	334	11.6	228	11.5	240	13.0	315	8.0

[1] Navy stations.

RIVERS AND FLOODS

[River and Flood Division, MONTROSE W. HAYES in charge]

By W. J. MOXOM

Flood producing rains, ranging in amount from 6 to 9 inches, fell on the night of June 30–July 1 in Texas in the central portions of the Colorado and Guadalupe Basins, and over the northern tributaries of the Neuces River. The flood in the Guadalupe River was severe, and was prolonged by continued rains. Crest stages below Gonzales, Tex., were the highest of record. The estimated losses were very large, amounting to approximately $2,130,000, of which nearly $1,500,000 was to matured and prospective crops. About 20 persons were drowned in the rapidly-rising creeks tributary to the main stream. Nine members of two families were lost in Plum Creek in Hays and Caldwell Counties. A freight train on the Missouri Pacific Railroad was wrecked in a creek near Kyle, Tex., resulting in the loss of two lives. The flood in the Colorado River was of short duration. The losses were not great; they were estimated at $37,000. In the Nueces River the rise was of moderate intensity, with crests 3 to 4 feet above flood stage, but the losses were considerable; they aggregated slightly more than $250,000, most of which was to matured and prospective crops.

Heavy wind and rainstorms in the Salt River Valley in Arizona on July 24, 25, and 26 caused rather severe local inundations on several creeks, with total losses estimated at $30,000. Two lives were lost.

Flood stages were exceeded at Fort Sumner, N. Mex., on the Pecos River; at Brownsville, Tex., on the Rio Grande, and at Fayetteville, Tenn., on the Elk River. The losses from these overflows were small.

Falling stages prevailed throughout most of the Mississippi System, and the lowest July stages of record occurred at many stations. In the Willamette and Columbia Basins the monthly mean stage was below the average at all gaging stations.

Table of flood stages during July 1936

[All dates in July, unless otherwise specified]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI SYSTEM					
Ohio Basin					
Elk: Fayetteville, Tenn.	*Feet* 14	4	5	*Feet* 22.3	4
Arkansas Basin					
Purgatoire: Higbee, Colo.	4	30	30	4.0	30
WEST GULF OF MEXICO DRAINAGE					
Colorado:					
Columbus, Tex.	24	2	3	31.7	3
Wharton, Tex.	26	3	4	32.9	4
Guadalupe:					
Gonzales, Tex.	20	1	5	38.2	1
Victoria, Tex.	21	1	9	30.7	4
		20	21	22.8	20
Nueces:					
Cotulla, Tex.	15	5	9	19.2	7
Three Rivers, Tex.	37	2	4	40.0	3
Pecos: Fort Sumner, N. Mex.	5	12	12	8.0	12
Rio Grande: Brownsville, Tex.	18	3	4	18.8	3
		17	18	19.3	17

WEATHER ON THE ATLANTIC AND PACIFIC OCEANS

[The Marine Division, I. R. TANNEHILL in charge]

NORTH ATLANTIC OCEAN, JULY 1936

By H. C. HUNTER

Atmospheric pressure.—Barometric pressure averaged less than normal during July over most of the North Atlantic Ocean and the adjacent shores. However, the southeast portion had somewhat greater average pressure than normal, the readings being notably high there from about the 6th to 16th, and again at the end of the month.

The highest pressure thus far reported was 30.64 inches, recorded during the forenoon of the 29th, near 44° N., 25° W., on the Dutch motor-tanker *Rotterdam*. The lowest pressure was 28.94 inches, on the British steamship *Badjestan*, about 2 p. m. the 2d, in approximately 56° N., 27° W.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, July 1936*

Station	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	29.84	+0.04	30.10	15, 16	29.50	3
Reykjavik, Iceland	29.81	−.03	30.15	29	29.38	6
Lerwick, Shetland Islands	29.72	−.08	30.03	28	29.26	15
Valencia, Ireland	29.81	−.17	30.39	30	29.26	23
Lisbon, Portugal	30.13	+.11	30.27	9, 31	29.83	22
Madeira	30.13	+.08	30.27	6	30.03	16, 21, 22, 26
Horta, Azores	30.31	+.04	30.56	29, 30, 31	30.06	25
Belle Isle, Newfoundland	29.77	−.12	30.16	24	29.30	1
Halifax, Nova Scotia	29.87	−.08	30.18	22	29.48	15
Nantucket	29.87	−.11	30.30	31	29.53	14
Hatteras	29.94	−.07	30.23	31	29.69	19
Bermuda	30.13	−.05	30.28	4	29.98	27, 28
Turks Island	30.04	−.03	30.08	1, 4, 17, 27	29.97	7, 24
Key West	30.01	−.02	30.12	4	29.79	29
New Orleans	30.00	.00	30.21	6	29.74	27

NOTE.—All data based on a. m. observations only, with departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.

Cyclones and gales.—Winds attained gale force on various dates over different parts of the ocean. About 300 miles south-southeast of Cape Race, during the forenoon of the 1st, the American liner *President Roosevelt* met a small-area storm of marked intensity, the wind reaching force 11, the only reported instance of force so great over the North Atlantic during the month. This storm formed the southern portion of a vast LOW, which advanced to eastward, with the result that other vessels, especially some near or to northward of the 50th parallel, had fresh to strong gales near midocean on the 1st or the 2d.

About the middle of the month several vessels met fresh to strong gales along or near the eastern half of the steamship lanes as far as the English Channel; while from the 17th to 20th, gales of similar force were encountered from the waters off the Carolinas to the southern shore of Newfoundland.

Strong trade winds.—During the first week unusually strong trades were noted by a few vessels in the Caribbean Sea and in the general region of the Bahamas. The British motorship *Nairnbank*, when near the Windward Passage on the 3d, encountered a whole gale (force 10), which is seldom experienced in such waters save in connection with a tropical disturbance. Near the Canary Islands the northeast trades were decidedly strong from the 9th to 12th. In Puerto Rican waters the trade winds were stronger than usual on the 21st; and over parts of the northern Caribbean Sea just before the month ended.

Tropical disturbances.—Elsewhere in this issue will be found the description of two tropical storms, one of which affected the Bahamas, Florida, and adjacent waters during the final week of the month. In respect to neither

gale force nor low readings of barometer at sea did this storm equal the extratropical storm over northerly waters during the first days of July. Chart IX presents the situation on the 27th, when the tropical storm was near the central Bahamas. There was a minor disturbance just north of the Mona Passage on the 22d, but it does not appear to have advanced or to have caused more than a brief period of winds of gale force.

Waterspout.—Early on the afternoon of the 20th a waterspout was noted in upper New York Harbor, starting not far off shore from Stapleton, Staten Island. For a few minutes it seemed to remain practically stationary, then moved slowly toward the northeast. After about 10 minutes it disappeared very suddenly. The height was estimated as more than 1,500 feet by officers of the Coast Guard.

Fog.—July 1936, was marked by about the same amount of fog as the preceding month of June, except for an increase in prevalence within a strip, between 45° and 50° north latitude, from Newfoundland eastward to a little beyond midocean.

Over the middle and western parts of the Grand Banks there was more than the normal July amount of fog. The region of greatest frequency, however, was in the square from 40° to 45° N., 65° to 70° W., which is adjacent to eastern New England and southern Nova Scotia. Here the reports indicate 19 days of fog.

From the vicinity of Nantucket southwestward to Chesapeake Bay there was less fog than normally occurs in July, there being scarcely any after the middle of the month.

Thick weather, due probably to dust from the African mainland, was reported south of the Canary Islands on the 9th.

On July 12 the steamships *Yarmouth* and *Losmar* collided in Boston Harbor during a fog, with considerable damage to each.

OCEAN GALES AND STORMS, JULY 1936

Vessel	Voyage		Position at time of lowest barometer		Gale began July	Time of lowest barometer July	Gale ended July	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN			° ′	° ′				*Inches*					
Pres. Roosevelt, Am. S. S.	Cobh	New York	41 50 N.	51 04 W.	1	9a, 1	1	29.17	S	W, 11	N	W, 11	S-W-N.
Quaker City, Am. S. S.	Liverpool	Boston	50 20 N.	37 00 W.	2	8p, 1	3	29.17	S	S, 7	WNW	WSW, 9	S-WNW.
Tetela, Br. S. S.	Port Antonio	Liverpool	46 37 N.	34 20 W.	1	10p, 1	2	29.69	W	SSW, 8	WNW	SSW, 8	SSW-WNW.
Veendam, Du. S. S.	Rotterdam	New York	48 37 N.	35 34 W.	1	11p, 1	3	29.22	SSW	SSW, 8	NNW	SSW, 8	SSE-SSW-WNW.
Nairnbank, Br. M. S.	Colon	do	12 57 N.	77 54 W.	1	2a, 2	4	29.84	E	E, 8	E	E, 10	Steady.
Helmstrath, Br. S. S.	Swansea	Montreal	53 02 N.	45 30 W.	1	4a, 2	2	[1]29.00	SW	SW, 4	N	N, 8	SW-N.
Badjestan, Br. S. S.	Newcastle	Sydney	56 18 N.	27 25 W.	3	2p, 2	4	28.94	NW	SW, 6	WNW	WNW, 8	SE-SW-W.
Sanyo Maru, Jap. M. S.	Cristobal	New York	10 36 N.	79 14 W.	5	7a, 5	6	29.74	ENE	NE, 5	ENE	ENE, 7	
Margaret, Am. S. S.	Jacksonville	San Juan	23 10 N.	69 10 W.	6	1a, 7	7	30.01	S	S, 8	SE	SE, 8	6 points to right.
Nishmaha, Am. S. S.	Hull	Port Tampa	46 33 N.	14 06 W.	8	10a, 8	8	29.38	W	WNW, 8	NW	NW, 8	WSW-NNW.
Roslin Castle, Br. M. S.	Las Palmas	Southampton	29 30 N.	13 00 W.	11	4a, 11	12	29.97	NE	NE, 8	NNE	NE, 9	
Tampa, Am. M. S.	Gibraltar	New York	42 04 N.	31 27 W.	15	Noon, 15	16	29.86	W	W, —	NW	W, 8	SW-W.
Lossiebank, Br. M. S.	Cape Town	Boston	39 12 N.	67 30 W.	15	7p, 15	15	29.78	WSW	WSW, 8	WSW	WNW, 8	
Exermont, Am. S. S.	Lisbon	New York	[2]41 34 N.	20 00 W.	16	4a, 16	16	29.78	SSW	W, 8	NW	W, 8	SSW-W.
Belgian Gulf, Belg. M. S.	Flushing	Port Arthur	46 10 N.	17 52 W.	16	5p, 16	17	29.49	WSW	WSW, 4	NNW	NNW, 9	SSW-WSW-NNW.
Seatrain New York, Am. S. S.	New York	New Orleans	32 18 N.	75 42 W.	17	7a, 17	17	29.97	SW	SW, 5	W	W, 8	SW-W.
West Harshaw, Am. S. S.	Avonmouth	do	49 16 N.	12 20 W.	17	10a, 17	17	29.30	NW	NW, 2	NW	NW, 9	SE-NW.
Laurent Meeus, Belg. M. S.	Houston	Amsterdam	[2]40 17 N.	56 37 W.	19	10a, 19	19	29.46	S	SW, —	SW	SW, 9	S-SW.
Tampa, Am. M. S.	Gibraltar	New York	42 45 N.	56 55 W.	20	8p, 20	20	29.68	SSE	SSE, 9	SW	SSE, 9	SSE-SW.
Geo. H. Jones, Am. S. S.	Baltimore	Guiria	19 00 N.	63 49 W.	21	4p, 21	22	29.93	ENE	ENE, 7	ESE	ENE, 7	
Yselhaven, Du. S. S.	Antwerp	Norfolk	49 55 N.	9 25 W.	22	8a, 23	24	29.49	SW	WSW, 8	W	W, 9	SSW-W.
Exermont, Am. S. S.	Lisbon	New York	40 38 N.	67 13 W.	25	8a, 26	25	29.69	S	W, 2	S	SSW, 8	
Helmstrath, Br. S. S.	Quebec	London	53 30 N.	26 39 W.	26	Noon, 26	27	[1]29.60	SW	WNW, 7	NW	NW, 8	WSW-WNW.
Tillie Lykes, Am. S. S.	Galveston	Port au Prince	[3]22 58 N.	79 04 W.	28	4a, 28	28	29.89	S	W, 3	SE	S, 6	W-S.
Yaka, Am. S. S.	Antwerp	Tampa	26 00 N.	76 50 W.	27	7a, 28	29	29.88	SE	SE, 6	SSE	S, 9	
Turrialba, Am. S. S.	Boston	Havana	26 20 N.	79 19 W.	28	6p, 28	29	29.75	ENE	ESE, 9	SSW	ESE, 9	
City of Omaha, Am. S. S.	Hamburg	Tampa	25 00 N.	80 10 W.	28	7p, 28	30	29.61	NE	NW, 10	S	NW, 10	N-WNW.
Atenas, Am. S. S.	Tela	Charleston	25 21 N.	80 00 W.	28	7p, 28	28	29.38	NNW	SE, 8	SSE	SE, 8	NNW-SSE.
Tillie Lykes, Am. S. S.	Port au Prince	Ciudad Trujillo	17 34 N.	72 20 W.	31	4p, 31	[3]1	29.89	E	ESE, 6	NE	ESE, 6	E-ESE-E.
NORTH PACIFIC OCEAN													
Washington, Am. S. S.	Longview	Shanghai	[2]51 59 N.	153 02 W.	5	2a, 6	6	29.93	SW	WSW, 8	W	SSW, 9	SSW-WSW.
Barentsz, Du. S. S.			16 31 N.	123 47 E.	8	10a, 8	8	28.65	N	W, 6	SW	NW, 12	NNW-W-S
Maunalei, Am. S. S.	Mahukona	San Francisco	37 30 N.	123 42 W.	13	2p, 14	14	29.87	NW	NNW, 7	NNW	NW, 8	
Washington, Am. S. S.	Longview	Shanghai	47 15 N.	158 45 E.	15	2p, 15	15	29.71	S	SSW, 8	W	SW, 8	S-WSW.
Pres. Jefferson, Am. S. S.	Yokohama	Victoria, B. C.	[2]48 08 N.	174 57 E.	19	Mdt, 18	18	29.84	SE	E, 5	SE	SE, 8	
Silveryew, Br. M. S.	Los Angeles	Manila	15 00 N.	131 25 E.	18	4a, 19	19	29.64	E	SE, 8	SW	SE, 8	SE-S-SW.
Laganbank, Br. M. S.	San Francisco	do	15 54 N.	128 16 E.	19	8a, 19	19	29.62	SW	SW, 5	SW	SW, 8	ESE-Var-SW.

[1] Barometer uncorrected. [2] August. [3] Position approximate.

NORTH PACIFIC OCEAN, JULY 1936

By WILLIS E. HURD

Atmospheric pressure.—The distinctive feature of the pressure situation over the North Pacific Ocean during July 1936 was the great extent of the oceanic HIGH from the northwestern coast of the United States southwestward to a considerable distance beyond Midway Island, and from the Hawaiian Islands to the sixtieth parallel in the southeastern part of the Bering Sea. The pressure departure from normal at Dutch Harbor was +0.15, and at St. Paul, +0.22, as shown in table 1. Except in the Aleutian region, barometers over the high-pressure area were not far from normal.

Over the extreme southeastern part of the ocean, pressures below normal occurred, the departure being −0.12 at Juneau. Pressures were slightly below normal along the American coast to the southward.

In Asiatic waters, from northern Japan southwestward, average barometric readings were below 29.80 inches.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean, July 1936, at selected stations*

Stations	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Point Barrow	29.72	−0.20	30.28	27	29.12	9
Dutch Harbor	30.09	+.15	30.36	18	29.34	1
St. Paul	30.06	+.22	30.44	20	29.40	5
Kodiak	29.93	−.01	30.22	18	29.48	9
Juneau	29.93	−.12	30.24	31	29.42	9
Tatoosh Island	30.04	−.01	30.23	29	29.68	4
San Francisco	29.89	−.06	30.00	11	29.74	14
Mazatlan	29.83	−.03	29.92	29	29.66	14
Honolulu	30.02	.00	30.12	31	29.92	15
Midway Island	30.10	−.01	30.20	23	29.98	13, 14
Guam	29.83	−.01	29.94	6	29.74	13, 16
Manila	29.74	.00	29.88	8	29.62	17, 29
Hong Kong [1]						
Naha	29.76	+.04	29.96	7	29.52	20, 21
Chichishima	29.91	+.06	30.04	16, 17	29.56	10
Urakawa	29.78		30.20	6	29.42	11

[1] Data missing.

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observation.

Cyclones and gales.—North Pacific weather in higher latitudes was for the most part quiet in July 1936. A few extratropical disturbances occurred; but only a small number was reported as causing winds of gale intensity, and these on only 5 days. The American steamship *Washington* was the only vessel to report a gale in excess of force 8. This was of force 9, encountered during the night of the 5th–6th, lowest barometer 29.93, in the neighborhood of 52° N., 153° W.

Tropical disturbances.—Subjoined is a report, by the Reverend Bernard F. Doucette, S. J., of the Philippine Weather Bureau, on five typhoons and one depression that occurred in the Far East during July 1936.

There is little to add to this account beyond a mention, in connection with the typhoon of July 16–25, of the fact that two vessels, the British motorships *Laganbank* and *Silveryew*, reported encountering gales of force 8 on the 19th within the neighborhood 15°–16° N., 128°–132° E.

Fog.—Along the northern steamship routes fog was frequent to the westward of the one hundred and sixtieth meridian of west longitude, the occurrence increasing from about 20 percent in the eastern area to about 70 percent in the neighborhood of northern Japan. As an illustration of the persistence of fog in the trans-Pacific travel of the month: The American S. S. *President Jefferson* entered fog at 3 p. m. of the 15th, in 38°13′ N., 145°43′ E., and did not leave it until 4 p. m. of the 18th in 47°30′ N., 171°36′ E. There were 13 days with fog reported off the California coast; and 9 days off the coast of Lower California.

TYPHOONS AND DEPRESSION OVER THE FAR EAST, JULY 1936

By REV. BERNARD F. DOUCETTE, S. J.

[Weather Bureau, Manila, P. I.]

Five typhoons and one depression occurred during the month of July 1936 over the Philippines and adjoining regions.

Typhoon, July 1 to 5, 1936.—A typhoon appeared the morning of July 1 about 400 miles east of southern Samar and moved west-northwest toward northern Luzon, which was in danger until the forenoon of July 3. The storm then shifted to the north, afterward northwest, and moved rapidly across the Balintang Channel. It entered the continent close to Swatow the morning of July 5 and soon changed its course to the east. By this time it had weakened considerably and on the following morning had disappeared. The typhoon was small and the winds were not violent over northern Luzon, July 3, consequently little damage resulted.

Typhoon, July 5–10, 1936.—From July 2 to 4, pressure was low over the Eastern and Western Caroline Islands; but no definite center appeared until July 5, when the morning weather map showed the existence of a depression about 200 miles north-northeast of Yap. During the next 2 days the depression moved west-northwest quite rapidly, intensifying as it progressed. The morning of July 8 found it about 300 miles east-northeast of Manila moving west-northwest. It passed north of and close to Tuguegarao, Cagayan Province, the afternoon of the same day. The next morning, the typhoon was over the northern part of the China Sea, much decreased in intensity, and moving northward toward the Continent, which it entered July 10.

The location of the typhoon on the morning of July 8 was known from observations sent to the Observatory by Captain Weber of the S. S. *Barentsz*. His ship encountered the typhoon winds and rain and passed through the center (9:20 to 9:30 a. m., position at 9 a. m. lat. 16.32 long. 123.44) with a barometric minimum of 727.7 mm (28.650 in.). The pressure had fallen from 750.0 mm (29.528 in.) to this value in about 1 hour (8.25 a. m. to 9:20 a. m.) and regained the higher value at 10:30 a.m. The winds were of hurricane force but there was no warning swell in advance of the typhoon. The evidence obtained by the officers of the ship plainly indicates that the typhoon was very small, with the destructive winds extending only over a small area. At Tuguegarao, Cagayan Province, a barometric minimum of 742.46 mm (29.270 in.) was observed July 8, 5:16 p. m.

Two people were crushed by falling trees near Tuguegarao. The M. S. *Marie* was lost 8 or 10 miles south of Palinan along the eastern coast of Luzon. (Palinan Point is in lat. 17.10 N, long. 122.27 E). The crew, reported to be 26 in number, and 2 passengers were lost with the ship, according to newspaper reports, July 22.

Typhoon, July 16 to 25, 1936.—A depression appeared, July 16, about 200 miles west-northwest of Yap, moved west-northwest, gradually inclining to the north, passing over 300 miles east of the Philippines. When east of Formosa (July 21), it intensified and was a severe disturbance as it crossed the Loo Choos (Nansei) Islands about 50 miles west of Naha. It gradually recurved to the northeast, passing close to Kiushu Island on its way to and across the Sea of Japan. Thence it moved rapidly across northern Japan toward the Aleutian Islands. The newspapers of July 24 reported 4 deaths in Japan, many fishing boats lost, and certain districts flooded, with greatest damage at Kagoshima. The navy service ship, *Mamiya*, and the submarine *S-55* were beached near Sasebo, with some damage.

Typhoon, July 18 to 21, 1936.—A depression appeared about 300 miles west by south of Manila on July 18 and moved slowly in a northwesterly direction. On the 19th and 20th it intensified into a typhoon, which continued toward Hainan Island, but changed to the west when close to and south of the island. It entered Indochina, moving westerly, and gradually decreased in intensity.

It is to be noted that this typhoon, west of the Archipelago, and the preceeding typhoon, east of the Archipelago, were phenomena along the front extending from Indochina to the Caroline Islands. Both of these typhoons intensified within a day of each other, the one in the China Sea on the 19th, the Pacific disturbance on the 20th. Observations received from the S. S. *Kota Agoeng*

and the S. S. *Tjimanoek* showed the existence and position of this front east of the Archipelago, about latitude 13° N, on July 14 to 16, and on July 19, respectively. This intensification, in the opinion of the writer, was due to an increase of velocity of the easterly current of air, north of the front.

Typhoon, July 22 to August 3, 1936.—Forming between Yap and Palau Islands, a depression appeared July 24 and moved in a west-northwest direction. It was practically stationary July 27 and 28 about 300 miles east of San Bernardino Strait. About 10 a. m. on the latter day, it began to move in a northwest direction, developing as it moved. As it approached northern Luzon, it was a typhoon moving quite rapidly, and during the night of July 29 it crossed the Island between Aparri and Tuguegarao, inclining to the west-northwest. The next morning found it about 60 miles west of Laoag, Ilocos Norte, and very intense. From this position, it moved a short distance to the west-northwest and then inclined to the northwest and finally north, entering the continent close to Swatow. On August 3, the storm was located southwest of Shanghai, of considerable intensity, and moving in a northeast direction.

As the typhoon crossed northern Luzon, there were no high-velocity winds nor very low barometric minima. In the early morning hours of July 31 there seemed to be a secondary disturbance south of Vigan, Ilocos Sur, which caused easterly winds and heavy rains. This did not last very long, because of the very great intensity of the typhoon as it entered the China Sea. The S. S. *Empress of Russia*, enroute Hong Kong to Manila, passed through the center, reporting "July 31, 0230 G. M. T. lat. 18.45 N, long. 116.52 E. Now passing center typhoon, winds calm, 28.65 mer. cor." The next day, at 6 a. m. Pratas Island reported "variable winds, force 2, overcast 714.73 mm" (28.143 in.). Many ships around the typhoon, both north and south, reported winds of hurricane force while the storm was moving northward toward the continent.

Newspapers at Manila on August 1 reported a loss of life totaling seven, with possibility of more being reported later. The heavy rains in the mountains along the western coast of Luzon caused disaster along the river banks in the lowlands as the torrents rushed down the slopes to the sea. No reports have been received to date (Aug. 3) from China.

Depression, July 26 to August 3, 1936.—A depression of minor importance formed over the Western Caroline Islands, moved west-northwest and filled up over 300 miles east of northern Luzon.

CLIMATOLOGICAL TABLES

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, July, 1936

[For description of tables and charts, see REVIEW, January, p. 29]

Section	Temperature								Precipitation					
			Monthly extremes								Greatest monthly		Least monthly	
	Section average	Departure from the normal	Station	Highest	Date	Station	Lowest	Date	Section average	Departure from the normal	Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	81.8	+1.5	Troy	107	7	4 stations	60	31	7.19	+1.83	Clayton	13.70	Maxwell Field	2.58
Arizona	82.2	+.8	Gila Bend	123	17	Snowflake	27	1	2.32	+.40	2 stations	5.75	Yuma	.18
Arkansas	83.3	+2.8	2 stations	114	18	Lead Hill	42	31	4.90	+1.10	Pine Bluff	14.16	Rogers	.04
California	74.5	+.9	Greenland Ranch	125	[1] 17	Ellery Lake	26	11	.19	+.12	South Lake	2.14	46 stations	.00
Colorado	70.8	+3.7	Las Animas	112	26	3 stations	29	[1] 1	2.15	−.07	Holyoke	6.22	La Veta Pass	.03
Florida	81.8	+.5	De Funiak Springs	103	7	2 stations	61	10	6.46	−.76	Compass Lake	12.77	Lake Wales	2.38
Georgia	81.9	+1.8	Blakely	106	11	Blairsville	55	22	5.04	−.71	Douglas	15.07	Covington	.59
Idaho	71.2	+3.2	4 stations	112	[1] 19	Pelton Ranch	29	25	.73	+.08	Pocatello	2.44	Meridian	T
Illinois	83.5	+7.1	Greenville	115	12	Mount Carroll	44	[1] 30	1.22	−2.03	Effingham	4.55	Warsaw	T
Indiana	81.4	+5.7	Collegeville	116	14	Wheatfield	41	[1] 30	1.59	−1.72	Martinsville	5.51	2 stations	T
Iowa	83.4	+8.8	2 stations	117	25	2 stations	43	30	.51	−3.17	Osage	2.79	3 stations	.01
Kansas	85.7	+6.7	do	121	[1] 18	Osage City	50	31	.86	−2.34	Coffeyville	5.58	4 stations	T
Kentucky	81.4	+4.2	Henderson	113	13	Farmers	46	31	3.78	−.35	Mayfield	8.86	Irvington	.70
Louisiana	82.1	+.3	Plain Dealing	104	17	2 stations	56	31	6.42	+.25	Schriever	11.14	Burrwood	1.03
Maryland-Delaware	75.8	+.6	2 stations	109	10	Sines, Md	38	31	4.18	−.04	Friendsville, Md	8.58	Picardy, Md	2.61
Michigan	71.9	+2.8	Mio	112	13	2 stations	29	1	1.10	−1.80	East Tawas	4.11	Ann Arbor	.11
Minnesota	77.1	+7.1	Moorhead	114	6	do	35	[1] 2	.73	−2.57	Two Harbors	2.45	Little Falls	T
Mississippi	82.3	+1.2	Aberdeen	106	13	Booneville	61	31	6.00	+.95	Hattiesburg	11.39	Moorhead	2.96
Missouri	85.3	+7.3	2 stations	118	[1] 15	Goodland	44	31	1.52	−2.16	Campbell	6.55	4 stations	T
Montana	74.3	+7.4	Glendive	113	5	Summit	25	27	.73	−.73	Hebgen Dam	3.31	Big Timber	.05
Nebraska	83.6	+8.3	2 stations	118	[1] 17	Atkinson	44	11	.57	−2.59	Lebanon	2.70	3 stations	.00
Nevada	76.3	+3.9	do	115	[1] 17	San Jacinto	34	11	.80	+.43	Searchlight	2.97	Mina	.00
New England	67.8	−1.2	Waterbury, Conn	103	9	Somerset, Vt	30	1	2.71	−.98	First Conn. Lake, N. H.	6.20	Portland, Maine	.76
New Jersey	74.6	+.9	Runyon	110	10	Charlottesburg	40	31	2.47	−2.32	Bridgeton	6.44	Newton	.38
New Mexico	72.5	+.2	Hagerman	111	21	Therma	26	[1] 1	2.07	.00	Mosquero (near)	6.68	Ramah	T
New York	70.2	+.5	Lewiston	107	9	Indian Lake	31	1	2.13	−1.78	Canton	5.73	Geneva	.36
North Carolina	78.2	+1.2	Monroe	106	27	Mount Mitchell	40	31	6.83	+.99	Goldsboro	12.76	Monroe	3.41
North Dakota	79.9	+11.8	Steele	121	6	2 stations	38	[1] 1	.70	−1.72	Howard	2.47	Mandan	.00
Ohio	77.0	+3.3	Paulding	111	14	Millport	43	31	3.06	−.72	Cadiz	8.48	Springfield (no. 2)	.23
Oklahoma	86.5	+4.8	2 stations	120	[1] 18	Smithville	48	31	.71	−2.17	Smithville	7.39	3 stations	.00
Oregon	67.3	+.9	Prairie City	111	21	Meacham	26	25	.50	+.09	Headworks	2.73	do	.00
Pennsylvania	73.5	+1.3	Phoenixville	111	[1] 9	Gouldsboro	37	31	2.88	−1.40	York	7.68	Pleasant Mt	.37
South Carolina	81.5	+1.6	3 stations	105	[1] 2	Caesars Head	51	31	5.06	−.75	Camden	8.55	Garnett	2.04
South Dakota	84.2	+11.2	Gannvalley	120	5	Menno	42	2	.62	−1.83	Waters Ranch	3.29	2 stations	T
Tennessee	80.3	+2.6	Carthage	107	13	Rugby	45	31	6.75	+2.29	Coldwater	16.32	Etowah	1.99
Texas	82.5	−.5	Memphis	115	18	Midland	49	13	4.15	+1.52	Hallettsville	24.68	2 stations	.00
Utah	72.9	+1.2	St. George	111	17	Clear Creek	35	[1] 1	2.36	+1.45	Clear Creek	5.90	Bluff	.29
Virginia	77.1	+1.7	Lincoln	109	10	Mountain Lake	41	22	4.20	−.29	Dante	10.17	Rocky Mount	1.10
Washington	66.5	+.4	Wahluke (near)	111	20	Deer Park (near)	28	26	.86	+.17	Spruce	5.35	2 stations	.00
West Virginia	75.2	+2.1	Martinsburg	112	10	Bayard	35	31	5.10	+.52	McNeill	9.75	Parkersburg	1.17
Wisconsin	75.2	+5.1	Wisconsin Dells	114	13	2 stations	34	30	1.01	−2.54	Oconto	3.53	River Falls	.03
Wyoming	71.0	+5.4	Colony	110	6	Afton (near)	30	[1] 1	1.55	+.24	Encampment (near)	5.34	2 stations	.29
Alaska (June)	58.2	+5.4	2 stations	91	17	Barrow	16	9	.99	−.84	Ketchikan	4.56	Annex Creek	.15
Hawaii	75.0	+.8	3 stations	92	[1] 15	Kula Sanitarium	51	[1] 2	8.20	+2.30	Wahiawa Water Co. Intake.	48.30	2 stations	.00
Puerto Rico	78.2	−.2	Ponce	97	21	Guineo Reservoir	51	12	8.43	+1.68	La Mina	19.12	Central "San Francisco."	3.40

[1] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau stations, July 1936*

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	*° F.*	*° F.*	*°F.*		*°F.*	*° F.*		*°F.*	*° F.*	*° F.*	*° F.*	*%*	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
New England							68.2	−0.7										75	2.10	−1.4										5.5		
Eastport	76	67	85	29.77	29.84	−0.09	59.8	−0.6	83	8	68	48	23	52	24	56	54	85	1.08	−2.0	10	5,320	sw.	24	s.	24	2	14	15	6.9	0.0	0.0
Greenville, Maine	1,070	6	40	28.73	29.85	------	61.9	------	82	9	70	42	18	53	30	----	----	----	4.53	------	10	3,549	nw.	16	------	7	6	11	14	----	.0	.0
Portland, Maine	103	82	117	29.74	29.86	−.09	66.6	−1.5	96	8	75	51	1	58	31	60	56	70	.76	−2.5	10	5,808	s.	38	s.	24	17	8	6	4.0	.6	.0
Concord	289	60	----	----	----	----	68.4	−.1	94	8	80	42	1	57	36	----	----	----	3.76	+.2	9	------	nw.	----	----	----	15	9	7	----	.0	.0
Burlington	403	11	48	29.42	29.85	−.09	67.6	−2.7	91	8	77	47	1	58	33	61	56	69	3.67	+.2	11	5,166	nw.	26	s.	3	8	14	9	5.7	.0	.0
Northfield	876	12	60	28.94	29.87	−.07	64.6	−1.3	90	8	77	40	1	52	39	60	56	74	3.73	+.2	9	4,910	s.	23	s.	3	4	15	12	6.2	.0	.0
Boston [1]	29	31	50	29.83	29.86	−.10	71.1	−.6	98	8	80	57	1	62	29	63	59	71	1.04	−2.4	9	6,785	w.	34	nw.	9	7	15	9	5.9	.0	.0
Nantucket	12	14	90	29.86	29.87	−.11	67.4	−.4	83	10	74	57	21	61	21	62	60	84	1.58	−1.3	5	8,971	sw.	35	sw.	14	9	11	11	5.7	.0	.0
Block Island	26	11	46	29.85	29.88	−.09	68.0	−.4	85	9	74	59	1	62	30	64	63	88	1.34	−1.7	6	8,944	sw.	36	n.	9	11	12	8	5.2	.0	.0
Providence	160	215	251	29.71	29.88	−.09	71.6	−1.8	94	8	81	55	26	62	29	63	59	68	2.34	−.9	7	6,795	nw.	42	nw.	9	11	14	6	4.9	.0	.0
Hartford	159	70	104	29.70	29.87	−.10	73.0	+1.4	100	10	84	52	1	62	32	----	----	----	2.33	−2.0	6	5,400	s.	27	nw.	25	12	11	8	4.9	.0	.0
New Haven	106	74	153	29.77	29.88	−.09	72.6	+.8	94	8	81	57	1	64	27	64	60	68	1.45	−2.9	7	6,135	s.	30	n.	14	10	13	8	5.4	.0	.0
Middle Atlantic States							76.4	+1.5										69	3.65	−1.3										5.5		
Albany	97	97	112	29.77	29.87	−.09	74.4	+1.8	103	9	86	51	1	63	34	63	58	61	1.94	−1.5	7	5,076	s.	24	e.	12	9	21	1	4.5	.0	.0
Binghamton	871	57	79	29.00	29.91	−.06	71.8	+1.8	103	9	86	45	1	58	38	----	----	----	.88	−2.8	10	4,165	nw.	23	ne.	25	3	16	10	6.4	.0	.0
New York	314	415	454	29.55	29.88	−.10	74.8	+1.0	102	9	83	61	30	66	26	66	61	69	2.37	−1.9	8	8,940	n.	37	s.	29	11	12	8	5.0	.0	.0
Harrisburg	374	94	104	29.50	29.89	−.09	76.3	+1.5	103	9	87	58	27	66	33	66	61	63	5.02	+1.2	6	4,746	w.	34	ne.	14	13	13	5	4.4	.0	.0
Philadelphia	114	174	367	29.78	29.90	−.08	77.3	+1.1	104	10	86	62	30	68	29	67	63	66	2.60	−1.6	11	8,006	sw.	40	nw.	29	9	13	9	5.4	.0	.0
Reading	323	283	306	29.55	29.89	------	76.5	+1.0	102	10	86	58	31	67	28	66	60	61	1.73	−2.5	11	6,426	nw.	40	nw.	10	13	11	7	4.8	.0	.0
Scranton	805	72	104	29.05	29.90	−.08	73.7	+2.0	103	9	86	48	31	61	35	62	55	57	.73	−3.3	6	4,491	n.	21	nw.	29	6	22	3	5.0	.0	.0
Atlantic City	52	37	172	29.84	29.89	−.09	73.8	+1.7	94	9	80	62	7	68	22	68	66	79	3.74	−.2	12	9,747	s.	43	nw.	10	6	9	16	6.8	.0	.0
Sandy Hook	22	10	57	29.86	29.88	------	74.8	+1.3	101	9	82	63	30	68	27	67	64	75	1.66	−3.5	4	8,735	sw.	39	n.	14	11	9	11	5.2	.0	.0
Trenton	190	88	106	29.68	29.88	------	76.3	+1.8	106	9	87	60	30	66	33	66	61	65	1.75	−2.2	9	6,234	s.	27	nw.	24	11	11	9	5.1	.0	.0
Baltimore	123	100	215	29.77	29.90	−.08	78.6	+1.4	107	10	88	60	1	70	28	69	64	65	4.89	+.2	15	6,829	sw.	38	ne.	10	12	9	10	5.0	.0	.0
Washington	112	62	85	29.78	29.90	−.10	78.4	+1.6	105	10	88	62	30	69	33	69	65	68	4.07	−.6	11	4,287	sw.	25	nw.	23	9	12	10	5.5	.0	.0
Cape Henry	18	8	54	29.89	29.91	------	78.6	+1.1	97	10	86	62	30	71	26	73	70	81	2.70	−2.7	16	6,944	sw.	31	n.	30	7	13	11	6.3	.0	.0
Lynchburg	686	5	----	29.21	29.94	−.07	79.8	+2.3	106	10	93	58	23	67	36	----	----	----	3.07	−1.1	17	------	sw.	----	----	----	2	25	4	----	.0	.0
Norfolk	91	80	125	29.83	29.92	−.08	79.1	+.4	96	12	88	63	30	71	30	72	69	78	9.30	+3.6	14	5,954	w.	53	w.	29	6	10	15	6.7	.0	.0
Richmond	144	11	52	29.78	29.92	−.09	79.9	+1.4	105	10	90	62	31	70	32	71	68	75	3.18	−1.6	12	5,143	sw.	34	nw.	12	6	14	11	6.2	.0	.0
Wytheville	2,304	49	55	------	29.92	−.09	74.2	+1.6	95	10	85	51	22	64	33	----	----	72	2.33	−1.7	15	4,773	w.	20	w.	1	8	11	12	----	.0	.0
South Atlantic States							81.0	+1.8										75	6.31	+0.5										5.6		
Asheville	2,253	89	104	27.70	29.97	−.05	75.6	+3.9	99	10	87	55	31	64	32	67	64	77	6.77	+2.5	16	4,376	nw.	31	w.	6	4	12	15	6.8	.0	.0
Charlotte	779	63	86	29.14	29.96	−.06	80.9	+2.5	101	27	91	57	31	70	28	70	67	68	9.18	+4.1	11	4,894	sw.	25	n.	29	6	12	13	6.1	.0	.0
Greensboro	886	6	56	29.02	29.95	------	78.0	------	99	27	89	57	30	67	32	70	68	78	8.01	------	15	5,046	sw.	42	w.	29	5	17	9	6.0	.0	.0
Hatteras	11	5	50	------	29.94	−.07	78.8	+.6	92	28	84	66	15	74	19	----	----	77	5.88	+.4	11	8,779	sw.	58	nw.	1	14	10	7	----	.0	.0
Raleigh	376	103	146	29.54	29.92	−.10	79.9	+1.1	98	29	90	56	30	70	27	72	70	79	11.65	+6.2	16	5,538	sw.	41	nw.	2	8	17	6	5.2	.0	.0
Wilmington	72	73	107	29.88	29.96	−.05	80.4	+1.3	102	28	89	62	31	72	27	74	72	80	4.95	−2.2	10	6,815	sw.	28	w.	3	9	13	7	5.2	.0	.0
Charleston	48	11	92	29.93	29.98	−.05	82.9	+1.5	101	27	91	65	31	75	23	75	72	75	3.42	−3.5	8	7,860	sw.	37	n.	13	8	10	13	5.8	.0	.0
Columbia, S. C.	347	67	73	29.60	29.97	−.05	82.4	+1.5	101	28	93	58	31	72	30	72	68	69	7.10	+1.8	11	4,881	sw.	26	ne.	13	12	15	4	4.8	.0	.0
Greenville, S. C.	1,039	139	----	----	----	----	81.0	+4.1	100	11	92	56	31	70	33	----	----	----	4.93	−.4	8	------	w.	----	----	----	11	10	10	----	.0	.0
Augusta	182	62	77	29.76	29.95	−.07	83.4	+2.1	102	27	94	59	31	73	31	72	68	67	2.98	−2.4	12	4,853	w.	24	w.	3	6	17	8	5.8	.0	.0
Savannah	73	150	152	29.92	29.99	−.04	82.8	+1.3	100	27	92	64	31	73	27	74	72	78	6.68	.0	13	7,996	w.	36	nw.	13	12	14	5	4.5	.0	.0
Jacksonville	43	86	110	29.97	30.02	−.01	82.4	+.3	97	27	91	69	10	74	22	74	71	76	5.88	−.8	11	6,059	sw.	24	sw.	31	10	11	10	5.6	.0	.0
Florida Peninsula							82.6	+0.7										77	7.13	+1.6										5.5		
Key West	22	10	64	29.99	30.01	−.02	83.2	−0.3	91	20	88	72	5	78	16	77	75	77	4.02	+.7	11	7,281	e.	38	nw.	28	11	13	7	5.1	.0	.0
Miami	25	124	168	30.00	30.03	−.01	82.2	+1.2	90	21	88	66	13	77	21	76	74	76	8.52	+3.1	18	7,309	se.	44	se.	29	10	13	8	5.4	.0	.0
Tampa	35	88	197	30.00	30.03	−.01	82.4	+1.2	94	28	90	68	4	75	24	75	73	78	8.85	+.9	16	7,331	w.	43	s.	23	6	14	11	6.1	.0	.0
Titusville	43	5	36	29.98	30.03	------	81.2	------	96	27	90	67	10	72	23	----	----	----	3.60	------	10	------	sw.	----	----	----	10	10	11	----	.0	.0
East Gulf States							81.7	+1.1										77	6.82	+1.1										6.3		
Atlanta [1]	976	5	53	28.97	29.96	−.06	81.2	+3.1	100	10	92	59	31	71	36	71	68	73	4.03	−.6	11	5,729	w.	32	sw.	13	4	11	16	6.8	.0	.0
Macon	370	79	87	29.59	29.98	−.04	82.4	+1.2	99	10	92	61	31	72	27	73	70	72	7.48	+2.7	7	5,119	sw.	47	se.	16	6	15	10	5.6	.0	.0
Thomasville	273	49	58	29.72	30.00	−.03	81.8	.0	98	11	92	67	14	71	26	74	71	77	7.31	+.6	10	------	sw.	----	----	----	5	15	11	----	.0	.0
Apalachicola	35	11	----	29.97	30.01	------	82.0	------	94	7	89	70	22	76	18	75	----	----	10.14	+2.4	13	------	w.	40	e.	30	2	16	13	----	.0	.0
Pensacola	56	149	185	29.94	30.00	−.01	80.7	−.3	91	7	86	67	31	75	23	75	73	79	4.82	−2.0	13	9,236	sw.	55	n.	31	4	19	8	5.9	.0	.0
Anniston	741	9	----	----	----	----	81.4	+3.5	101	10	92	62	31	71	30	----	----	----	3.59	−1.6	11	------	sw.	----	----	----	13	9	----	----	.0	.0
Birmingham	700	11	48	29.23	29.98	−.03	80.7	+.5	102	10	91	60	31	71	31	72	70	77	8.52	+3.4	16	4,431	s.	23	s.	2	4	15	12	6.5	.0	.0
Mobile	57	86	105	29.93	29.99	−.02	82.3	+.9	100	7	91	68	14	74	31	75	72	78	6.13	−.8	16	5,984	s.	32	ne.	7	1	22	8	6.6	.0	.0
Montgomery	218	92	105	29.75	29.99	−.03	82.4	+.7	102	11	92	62	31	73	31	73	71	78	9.16	+4.3	15	5,117	sw.	33	ne.	31	5	13	13	6.5	.0	.0
Meridian	375	67	92	29.60	29.98	−.04	81.5	+1.1	100	11	92	63	31	72	30	73	71	79	6.22	+1.3	17	4,447	sw.	28	sw.	11	8	11	12	6.0	.0	.0
Vicksburg	247	65	73	29.73	29.99	−.01	81.0	−.3	95	27	89	65	31	72	24	74	72	79	5.95	+1.4	10	4,816	s.	27	s.	1	7	10	14	6.1	.0	.0
New Orleans	53	76	84	29.95	30.00	.00	83.6	+1.2	96	7	91	71	5	76	20	75	73	77	8.43	+2.1	11	4,755	sw.	23	e.	27	3	18	10	6.6	.0	.0
West Gulf States							83.0	+0.5										74	4.62	+1.4										4.8		
Shreveport	249	92	227	29.71	29.97	−.01	83.4	+.2	100	18	93	64	31	74	27	74	70	72	3.27	−.3	6	7,230	sw.	29	s.	21	10	12	9	5.2	.0	.0
Bentonville	1,303	12	38	28.63	29.95	−.02	84.5	+6.0	111	18	98	56	31	71	34	----	----	----	.18	−3.5	5	4,615	sw.	25	n.	18	11	18	2	----	.0	.0
Fort Smith	457	79	94	29.46	29.92	−.05	86.4	+4.9	110	18	98	66	31	74	31	71	64	55	1.12	−2.2	7	5,594	sw.	30	n.	19	14	13	4	4.4	.0	.0
Little Rock	357	94	102	29.58	29.95	−.04	82.6	+1.7	104	18	92	65	21	73	27	74	71	71	7.51	+4.0	7	5,888	sw.	30	e.	20	12	9	10	4.8	.0	.0
Austin	605	136	148	29.33	29.96	------	82.2	−1.8	96	30	91	69	16	73	24	73	71	76	9.25	+6.9	11	5,151	se.	27	se.	7	13	16	2	4.1	.0	.0
Brownsville	37	88	96	29.85	29.91	------	82.8	−.8	96	31	90	71	11	76	22	76	75	83	5.43	+3.5	9	7,314	se.	26	e.	13	10	14	7	5.4	.0	.0
Corpus Christi	20	11	78	29.92	29.94	−.02	83.2	+.5	94	31	89	73	3	78	17	77	75	81	2.17	+.6	9	8,137	s.	31	s.	1	12	9	10	5.2	.0	.0
Dallas	512	220	227	29.39	29.93	------	83.0	------	104	19	93	66	20	73	32	72	68	66	3.54	+.7	4	7,767	se.	68	n.	20	17	10	4	3.6	.0	.0
Fort Worth	679	92	110	29.25	29.95	−.01	84.4	+.8	104	19	95	67	20	74	37	----	----	----	2.35	−.3	6	6,954	s.	27	sw.	4	20	9	2	2.7	.0	.0
Galveston	54	106	114	29.92	29.98	−.00	82.8	−.6	93	30	87	71	2	78	16	76	74	78	4.57	+.9	12	8,098	s.	29	s.	1	13	10	8	5.2	.0	.0
Houston	138	292	314	29.83	29.97	------	81.9	−1.8	95	30	90	68	13	74	26	----	----	----	5.12	+1.1	11	7,373	s.	31	ne.	13	7	12	12	5.6	.0	.0
Palestine	510	64	72	29.45	29.97	.00	80.8	−1.4	95	13	90	66	31	72	27	73	71	79	7.38	+4.7	14	4,980	s.	23	s.	15	7	15	9	5.4	.0	.0
Port Arthur	34	58	66	29.94	29.98	------	83.1	------	95	9	90	70	31	76	22	76	73	77	10.15	+3.2	9	5,947	s.	34	ne.	9	8	16	7	5.5	.0	.0
San Antonio	693	242	301	29.23	29.93	−.02	81.6	−2.2	96	30	90	69	7	73	22	73	70	75	2.68	+.5	11	7,374	e.	32	se.	22	7	17	7	5.6	.0	.0

[1] Observations taken at airport.

TABLE 1.—*Climatological data for Weather Bureau stations, July 1936*—Continued

District and station	Elevation of instruments: Barometer above sea level	Thermometer above ground	Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Sea level, reduced to mean of 24 hours	Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Departure from normal	Days with 0.01 inch, or more	Wind: Total movement	Prevailing direction	Maximum velocity: Miles per hour	Direction	Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Ohio Valley and Tennessee	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	° *F.*	° *F.*	°*F.*		°*F.*	° *F.*		°*F.*	° *F.*	° *F.*	° *F.*	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
							80.3	+3.8										62	3.75	0.0										4.9		
Chattanooga	762	71	214	29.18	29.96	−0.06	81.6	+3.2	103	13	91	65	31	72	28	72	68	70	6.89	+2.6	11	5,662	w.	30	w.	2	7	16	8	5.5	0.0	0.0
Knoxville	995	66	84	28.94	29.96	−.06	80.4	+3.3	101	10	90	61	22	71	30	71	68	71	7.94	+3.6	10	4,219	sw.	20	ne.	10	10	12	9	5.1	.0	.0
Memphis	399	78	86	29.54	29.95	−.05	82.0	+1.3	97	13	89	66	31	75	25	74	70	72	6.49	+3.3	8	5,737	sw.	27	nw.	20	7	18	6	5.1	.0	.0
Nashville	546	168	188	29.40	29.97	−.04	81.2	+2.1	101	13	91	64	31	72	29	72	69	71	8.33	+4.4	12	5,865	sw.	38	se.	11	4	16	11	5.8	.0	.0
Lexington	989	6					81.1	+5.2	108	10	94	54	31	68	37				2.85	−.8	13		sw.				17	9	5		.0	.0
Louisville	525	188	234	29.38	29.95	−.05	83.3	+4.7	107	14	93	58	30	73	29	70	64	59	1.81	−1.9	8	7,373	sw.	37	nw.	16	14	14	3	4.0	.0	.0
Evansville	431	76	116	29.48	29.94	−.06	85.1	+6.2	108	13	96	60	30	74	27	71	66	59	.69	−2.7	6	6,472	sw.	34	nw.	16	13	15	3	4.4	.0	.0
Indianapolis	822	194	230	29.07	29.93	−.06	82.8	+7.1	106	14	94	56	30	72	31	68	59	50	.67	−2.7	7	6,760	sw.	33	w.	23	10	17	4	5.2	.0	.0
Terre Haute	575	63	149	29.31	29.91		85.4		110	14	98	57	30	73	30	69	62	52	4.51	+1.3	6	6,185	sw.	30	n.	25	12	15	4	4.4	.0	.0
Cincinnati	627	11	51	29.28	29.94	−.06	81.7	+6.6	106	14	93	57	31	70	33	69	63	59	.84	−2.5	6	5,018	sw.	21	nw.	11	14	10	7	4.6	.0	.0
Columbus	822	90	210	29.08	29.93	−.07	79.6	+4.7	106	14	92	55	31	68	34	69	58	52	1.80	−1.8	5	5,632	s.	38	nw.	11	15	12	4	4.2	.0	.0
Dayton	900	58	153	29.00	29.92		81.4	+6.0	106	14	93	58	31	70	31				1.38	−1.9	5	5,789	sw.	37	sw.	23	15	11	5	4.0	.0	.0
Elkins	1,947	59	78	27.99	29.96	−.05	70.9	+.6	96	10	83	46	31	59	38	64	62	80	8.12	+2.7	14	3,492	n.	34	nw.	5	9	14	8	5.8	.0	.0
Parkersburg	637	77	84	29.32	29.97	−.04	77.6	+2.2	103	14	89	52	31	66	35	67	61	60	1.17	−3.1	10	4,049	nw.	30	nw.	4	13	12	6	4.5	.0	.0
Pittsburgh [1]	842	164	410	28.62	29.93	−.07	75.0	+.4	102	14	87	52	30	63	32	63	56	57	3.07	−1.0	7	6,446	nw.	34	nw.	23	7	15	9	5.6	.0	.0
Lower Lake Region							73.4	+1.9										58	2.06	−1.2									4.0		
Buffalo	768	243	280	29.10	29.91	−.06	71.2	+1.4	96	12	78	53	1	64	22	63	57	63	1.08	−2.0	5	8,303	sw.	32	sw.	25	14	16	1	4.0	.0	.0
Canton	448	10	61	29.39	29.86		67.8	−2.7	95	10	79	45	1	56	32	61	57	69	5.73	+2.2	13	4,813	w.	25	w.	25	8	18	5	5.4	.0	.0
Ithaca	836	77	100	29.02	29.90		71.4	+.9	103	9	86	43	1	57	38	62	56	58	2.11	−1.4	7	5,189	nw.	21	nw.	23	7	18	6	5.3	.0	.0
Oswego	335	71	85	29.52	29.89	−.07	69.8	−.6	94	10	78	49	1	62	25	63	58	67	1.34	−1.6	8	5,739	w.	27	nw.	25	14	13	4	4.0	.0	.0
Rochester	523	86	102	29.36	29.92	−.05	72.7	+2.0	102	10	83	43	1	62	30	62	54	52	1.24	−1.7	3	5,511	w.	22	w.	25	16	12	3	3.7	.0	.0
Syracuse	596	65	79	29.27	29.90	−.07	73.0	+2.4	102	9	84	48	1	62	36				.67	−3.0	5	5,253	nw.	23	nw.	25	12	14	5	4.5	.0	.0
Erie	714	130	166	29.18	29.93	−.05	74.0	+3.0	98	9	82	54	2	66	24	64	58	59	.91	−2.1	4	6,904	n.	24	sw.	23	21	8	2	2.8	.0	.0
Cleveland	762	267	318	29.14	29.94	−.05	74.6	+3.2	99	11	82	57	2	68	26	64	57	56	2.23	−1.2	4	7,606	n.	51	w.	23	20	7	4	3.2	.0	.0
Sandusky	629	5	67	29.28	29.95	−.04	76.2	+2.8	105	14	86	55	31	66	34				3.21	−.2	5	5,043	ne.	20	w.	23	16	9	6	4.1	.0	.0
Toledo	628	79	87	29.29	29.96	−.03	76.0	+2.8	105	14	87	52	1	65	30	64	58	56	3.26	+.2	5	5,681	n.	26	w.	23	17	11	3	3.3	.0	.0
Fort Wayne	857	69	84	29.04	29.94		79.0	+5.5	106	14	91	55	30	67	33	65	57	51	2.14	−1.5	5	5,290	ne.	24	sw.	23	11	16	4	4.1	.0	.0
Detroit [1]	626	5	78	29.28	29.95	−.03	74.7	+2.6	104	8	87	49	1	62	35	63	55	52	.81	−2.5	3	5,515	ne.	24	nw.	27	16	13	2	3.7	.0	.0
Upper Lake Region							72.3	+4.4										60	0.70	−2.4									3.4		
Alpena	609	13	89	29.30	29.96	−.01	70.1	+4.2	104	13	81	46	1	59	37	62	56	62	1.02	−1.7	4	6,723	nw.	29	nw.	23	20	9	2	2.8	.0	.0
Escanaba	612	54	60	29.31	29.96	−.01	69.9	+3.9	99	13	80	49	3	60	27	62	57	64	.46	−2.9	5	6,352	s.	30	n.	23	17	12	2	3.2	.0	.0
Grand Rapids	707	70	244	29.20	29.94	−.04	77.3	+5.0	108	13	90	52	30	65	35	64	57	53	.79	−2.1	7	6,311	n.	30	sw.	9	16	13	2	3.4	.0	.0
Lansing	878	5	90	29.03	29.95		72.3	+1.4	101	14	85	49	30	60	37	63	59	62	1.22	−1.9	4	4,934	nw.	21	n.	26	17	13	1	2.9	.0	.0
Ludington	637	5	54	29.27	29.96		71.1	+4.9	97	13	82	51	1	61	30	62			.57	−2.5	4		n.				17	13	1		.0	.0
Marquette	734	77	111	29.17	29.96	.00	69.7	+4.8	104	13	79	47	2	60	39	61	56	63	.44	−2.7	5	5,287	w.	30	sw.	7	15	10	6	4.0	.0	.0
Sault Sainte Marie	614	11	52	29.27	29.95	−.02	67.6	+3.8	96	11	80	42	1	56	39	60	55	65	1.02	−1.9	6	4,814	nw.	25	nw.	28	19	9	3	3.2	.0	.0
Chicago	673	7	131	29.23	29.95	−.03	76.8	+4.3	102	10	85	58	31	69	25	66	61	62	.22	−3.1	5	5,315	ne.	20	n.	27	17	12	2	3.3	.0	.0
Green Bay	617	109	141	29.29	29.94	−.03	75.1	+5.1	104	13	86	54	1	64	36	63	56	54	1.02	−2.4	6	6,768	n.	27	sw.	22	13	13	5	4.1	.0	.0
Milwaukee	681	97	221	29.23	29.96	−.01	74.8	+4.7	101	9	82	56	1	67	34	63	57	56	.28	−2.6	5	7,498	e.	28	ne.	26	13	15	3	3.9	.0	.0
Duluth	1,133	5	47	28.74	29.93	−.02	70.6	+6.7	106	13	82	46	1	59	42	60	55	62	.63	−3.1	6	7,272	ne.	34	ne.	14	16	11	4	3.4	.0	.0
North Dakota							80.8	+12.3										46	0.74	−1.8									2.4		
Moorhead, Minn	940	50	58	28.88	29.86	−.08	80.2	+12.1	114	6	94	49	29	66	46	65	56	48	.42	−3.0	4	6,474	s.	24	s.	7	17	12	2	2.9	.0	.0
Bismarck	1,674	8	57	28.09	29.81	−.12	83.4	+13.6	114	6	98	55	1	69	42	64	53	41	.10	−2.1	2	7,511	se.	34	n.	8	23	8	0	2.3	.0	.0
Devils Lake	1,478	11	44	28.34	29.86	−.07	79.0	+11.6	112	6	94	47	29	64	45	64	55	51	1.55	−1.0	4	6,693	se.	44	nw.	8	21	10	0	2.6	.0	.0
Grand Forks	833	12	67				79.2		109	12	94	44	29	64	43	65			.66		4		se.	31	se.	9	12	17	2		.0	.0
Williston	1,878	42	50	27.91	29.82	−.10	80.8	+11.9	110	5	95	51	1	66	41	63	52	45	.87	−1.0	7	6,280	se.	30	se.	23	23	8	0	2.0	.0	.0
Upper Mississippi Valley							83.3	+8.2										51	0.88	−2.6									3.1		
Minneapolis	919	105	208	28.96	29.92		81.4	+9.1	108	14	92	55	29	70	36	65	56	46	.11	−3.6	6	7,096	s.	32	nw.	14	19	8	4	3.4	.0	.0
La Crosse	714	11	48	29.16	29.91	−.05	79.5	+6.7	108	14	93	49	30	66	35	66	60	57	1.61	−2.3	6	3,416	se.	15	ne.	18	18	8	5	3.0	.0	.0
Madison	974	70	78	28.92	29.93	−.04	78.8	+6.7	107	14	90	55	1	68	31	66	60	56	.99	−2.9	5	5,356	e.	21	ne.	15	17	10	4	3.7	.0	.0
Charles City	1,015	10	51	28.87	29.91	−.05	80.2	+7.9	106	14	94	48	30	66	39	66	58	50	.80	−3.0	7	4,593	se.	24	s.	22	21	8	2	2.3	.0	.0
Davenport	606	66	161	29.27	29.92	−.05	85.0	+9.7	111	14	97	58	30	73	36	68	60	48	.14	−3.2	4	5,782	ne.	24	se.	19	13	16	2	3.6	.0	.0
Des Moines	861	5	99	29.02	29.89	−.07	85.8	+10.4	110	25	99	56	31	72	34	68	57	42	.41	−3.1	1	6,207	s.	41	nw.	19	24	7	0	2.0	.0	.0
Dubuque	700	60	79	29.19	29.92	−.05	81.1	+7.0	110	14	95	52	30	68	37	67	59	51	.71	−3.2	7	4,017	e.	17	nw.	22	20	7	4	3.3	.0	.0
Keokuk	614	64	78	29.27	29.90	−.08	87.0	+10.1	113	15	99	61	31	75	35	68	58	41	.01	−3.4	1	5,182	sw.	21	sw.	4	21	7	3	3.0	.0	.0
Cairo	358	87	93	29.56	29.93	−.07	82.6	+3.0	105	13	92	62	31	74	27	74	71	73	2.64	−.4	7	5,513	sw.	27	se.	7	11	14	6	4.7	.0	.0
Peoria	609	11	45	29.28	29.94	−.04	84.3	+8.9	113	15	99	53	30	70	36	69	62	52	1.24	−2.3	4	4,113	ne.	18	sw.	23	20	11	0	2.5	.0	.0
Springfield, Ill	636	5	191	29.26	29.91	−.07	86.2	+9.7	110	14	98	58	30	74	34	69	61	48	1.36	−1.5	7	7,167	w.	32	ne.	15	17	11	3	3.3	.0	.0
St. Louis	568	179	303	29.33	29.92	−.07	87.4	+8.6	109	14	98	64	30	77	26	70	62	49	.60	−2.4	4	7,975	sw.	42	ne.	19	24	6	1	2.1	.0	.0
Missouri Valley							86.4	+10.3										41	0.65	−3.1									2.1		
Columbia, Mo	784	6	84	29.12	29.91	−.07	86.6	+9.7	111	15	100	59	31	73	38				.97	−2.5	5	5,588	sw.	26	nw.	19	22	8	1	2.3	.0	.0
Kansas City [1]	750	32	45	29.12	29.90	−.07	87.8	+9.7	109	24	101	58	31	74	41	69	59	44	.36	−3.8	2	6,855	sw.	56	nw.	27	26	5	0	2.2	.0	.0
St. Joseph	967	11	49	28.90	29.89		87.0		108	25	100	63	31	74	35	68	58	43	.95	−2.7	3	5,644	s.	38	n.	19	28	3	0	1.2	.0	.0
Springfield, Mo	1,324	98	104	28.57	29.94	−.04	84.2	+7.4	106	15	95	60	31	73	34	68	61	52	1.11	−3.1	6	6,278	s.	40	sw.	16	25	6	0	2.1	.0	.0
Iola	984	11	50	28.94	29.91	−.06	86.6	+8.4	114	18	101	55	31	72	39				.96	−2.8	3		sw.				17	13	1		.0	.0
Topeka	987	65	87				88.4	+10.6	114	24	102	60	31	74	46				1.11	−3.2	1	6,599	s.	40	nw.	27	22	9	0	2.2	.0	.0
Lincoln	1,189	11	81	28.65			87.9	+11.4	115	25	101	59	2	75	38			36	.08	−3.8	3	7,461	s.	34	ne.	19	20	9	2		.0	.0
Omaha	1,105	170	200	28.87	29.88	−.07	86.7	+10.0	114	25	100	58	31	73	39	68	57	42	.52	−3.0	1	6,769	s.	73	n.	19	25	4	2	2.3	.0	.0
Valentine	2,598	47	54	27.25	29.88	−.05	84.0	+10.3	108	5	98	56	1	70	47	63	49	35	.04	−3.0	2	7,634	s.	30	sw.	31	25	5	1	2.2	.0	.0
Sioux City	1,138	64	106	28.69	29.85	−.10	87.2	+12.9	111	17	100	57	2	74	40	67	56	38	.18	−3.4	4	6,725	s.	36	n.	2	19	11	1	2.7	.0	.0
Huron	1,307	59	74	28.50	29.85	−.09	84.4	+12.6	110	17	100	56	2	69	41	65	52	38	.85	−2.3	5	7,642	se.	33	w.	19	25	6	0	2.0	.0	.0
Northern Slope							76.1	+8.4										42	1.01	−0.5									4.0		
Havre	2,505	11	67	27.28	29.83	−.08	79.9	+11.6	107	17	96	51	26	64	44	58	41	32	.11	−1.8	5	6,192	nw.	40	sw.	17	17	12	2	3.3	.0	.0
Helena	4,124	85	111	25.81	29.89	−.04	74.7	+9.0	100	22	89	49	12	60	39	57	46	43	.69	−.4	9	6,222	sw.	38	s.	15	9	17	5	4.8	.0	.0
Missoula	3,263	80	91				74.4	+6.8	105	22	91	48	26	58	45				.50	−.5	5	4,900	se.	30	se.	2	18	9	4	3.2	.0	.0
Kalispell	2,973	48	56		29.86	−.07	70.6	+6.5	98	17	87	42	12	54	43			44	.45	−.6	4	5,011	w.	21	s.	2	20	10	1		.0	.0
Miles City	2,371	48	55	27.37	29.83	−.09	84.2	+11.3	108	5	97	54	1	71	36	62	47	34	1.00	−.5	3	6,637	s.	26	nw.	11	19	11	1	3.1	.0	.0
Rapid City	3,259	50	58	26.58	29.88	−.05	82.4	+11.4	106	5	97	56	14	68	41	61	47	35	.27	−2.1	6	6,012	w.	30	n.	26	17	13	1	3.2	.0	.0
Cheyenne [1]	6,094	50	71	24.07	29.92	.00	72.4	+5.7	96	23	88	49	1	57	42	55	45	47	1.76	−.3	7	6,900	nw.	47	w.	11	9	16	6	4.8	.0	.0
Lander	5,372	60	68	24.72	29.92	.00	73.2	+5.8	98	22	88	51	12	58	40	56	46	47	2.28	+1.6	8	4,294	sw.	32	sw.	6	10	17	4	4.6	.0	.0
Sheridan	3,790	10	47	26.08	29.87		77.9		104	6	96	48	1	60	50	60	48	44	1.07	−.2	7	3,753	nw.	25	nw.	25	15	10	6	4.1	.0	.0
Yellowstone Park	6,241	12	46	23.99	30.00	+.08	66.6	+5.7	91	18	81	45	1	52	37	52	42	50	2.00	+.7	11	5,840	sw.	36	sw.	14	5	17	9	5.9	.0	.0
North Platte	2,821	11	51	27.05	29.88	−.05	82.8	+9.9	108	25	97	56	1	68	40	64	53	44	.96	−1.8	5	5,839	s.	23	s.	11	22	6	3	2.6	.0	.0

[1] Observations taken at airport.

TABLE 1.—*Climatological data for Weather Bureau stations, July 1936*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
Middle Slope							**83.4**	**+6.2**										**42**	**0.87**	**−1.9**										**3.0**		
Denver	5,292	106	113	24.81	29.91	0.00	77.3	+5.1	100	23	90	57	13	65	33	58	46	42	1.70	0.0	9	5,694	s.	24	se.	9	15	12	4	4.1	0.0	0.0
Pueblo	4,685	80	86	25.35	29.90	−.01	77.4	+3.2	100	24	91	56	2	64	39	59	47	43	1.42	−.5	6	5,270	e.	30	e.	1	19	9	3	3.6	.0	.0
Concordia	1,392	50	58	28.49	29.91	−.04	87.2	+9.2	113	24	100	61	31	74	45	66	54	37	.75	−3.0	3	6,202	sw.	24	sw.	27	21	8	2	2.6	.0	.0
Dodge City	2,509	10	86	27.40	29.92	−.01	83.8	+5.4	109	18	97	63	30	70	37	64	52	41	1.10	−2.0	6	8,943	s.	30	e.	29	20	9	2	2.3	.0	.0
Wichita	1,358	85	93	28.51	29.89	−.07	87.8	+8.4	112	18	100	65	31	76	34	67	55	39	.21	−3.2	2	8,097	sw.	25	sw.	24	21	7	3	2.4	.0	.0
Oklahoma City	1,214	10	47	28.67	29.91	−.05	86.7	+6.1	109	19	99	67	2	75	32	69	61	49	.06	−2.8	2	6,875	s.	21	s.	24	18	9	4	3.2	.0	.0
Southern Slope							**81.4**	**+0.2**										**58**	**1.37**	**−1.0**										**3.8**		
Abilene	1,738	10	52	28.16	29.92	−.01	84.1	+1.3	108	19	96	65	3	72	37	69	63	59	2.09	.0	5	7,056	s.	32	e.	30	19	9	3	3.1	.0	.0
Amarillo	3,676	10	49	26.32	29.94	+.02	80.6	+3.8	102	19	93	62	6	68	30	64	55	51	.51	−2.3	6	6,609	se.	25	se.	15	17	13	1	3.2	.0	.0
Del Rio	960	63	71	28.92	29.88	−.02	82.2	−4.1	97	20	92	65	2	73	27	72	69	71	1.45	−1.0	8	7,173	se.	41	nw.	2	7	17	7	5.3	.0	.0
Roswell	3,566	75	85	26.39	29.90	+.02	78.6	−.3	103	19	92	57	1	66	38	63	55	53	1.42	−.8	6	5,951	se.	34	nw.	1	14	14	3	3.5	.0	.0
Southern Plateau							**80.3**	**+1.7**										**46**	**1.73**	**+0.3**										**3.3**		
El Paso	3,778	82	101	26.17	29.83	−.01	82.6	+1.5	103	1	94	65	30	71	30	64	54	43	.68	−1.3	4	6,450	se.	26	ne.	1	19	10	2	3.1	.0	.0
Albuquerque	4,972	5	39	25.10	29.84	------	77.0	+.3	99	19	92	55	3	62	37	59	50	49	.67	−.7	8	6,331	n.	34	n.	21	15	12	4	3.5	.0	.0
Santa Fe	7,013	38	53	23.40	29.90	+.02	70.2	+1.2	91	19	83	51	12	58	36	55	46	52	3.29	+.9	12	4,180	e.	29	ne.	6	11	12	8	4.9	.0	.0
Flagstaff	6,907	10	59	23.45	29.84	+.01	66.9	+1.9	90	24	82	42	12	52	43	53	----	56	4.36	------	14	5,878	nw.	25	ne.	25	3	15	13	----	.0	.0
Phoenix	1,108	10	107	28.64	29.74	−.04	93.2	+3.4	114	17	106	68	25	80	37	70	57	37	2.49	+1.4	7	4,925	e.	41	ne.	25	18	13	0	2.8	.0	.0
Yuma	141	9	54	29.59	29.73	−.03	93.0	+2.2	118	14	107	67	11	79	42	72	62	42	.18	.0	2	4,529	s.	30	e.	16	25	6	0	2.0	.0	.0
Independence	3,957	5	26	25.93	29.87	+.04	79.3	+1.2	104	18	95	50	10	63	40	58	----	----	.43	+.1	7	------	s.	----	----	----	14	11	6	----	.0	.0
Middle Plateau							**75.9**	**+2.9**										**42**	**1.21**	**+0.7**										**3.8**		
Reno	7,527	61	76	25.45	29.84	−0.03	74.3	+4.2	102	19	90	47	11	58	44	54	41	37	.10	−.2	2	5,364	sw.	27	sw.	8	22	6	3	2.6	.0	.0
Tonopah	6,090	12	20	----	----	----	75.2	----	95	18	87	48	11	64	29	54	40	36	.59	------	4	------	se.	----	----	----	----	----	----	----	----	----
Winnemucca	4,344	18	56	25.58	29.86	−.04	75.3	+4.7	104	19	94	47	12	56	53	55	40	36	.71	+.5	4	5,233	sw.	30	sw.	8	13	16	2	3.4	.0	.0
Modena	5,473	10	43	24.65	29.87	+.01	71.8	+1.2	95	4	87	45	12	57	45	56	46	52	2.21	+1.1	16	6,991	sw.	35	w.	7	9	19	3	4.6	.0	.0
Salt Lake City [1]	4,537	86	210	25.72	29.87	−.03	78.2	+2.5	104	19	92	53	1	64	39	61	52	49	1.44	+.9	12	7,465	se.	48	w.	10	9	17	5	4.9	.0	.0
Grand Junction	4,602	60	68	25.40	29.90	+.01	79.8	+2.1	102	19	93	54	12	67	34	60	48	42	1.60	+1.0	10	5,365	se.	28	se.	17	16	12	3	3.7	.0	.0
Northern Plateau							**74.8**	**+4.2**										**40**	**0.64**	**+0.2**										**2.8**		
Baker	3,471	48	53	26.43	29.93	−.02	69.8	+4.2	99	20	86	43	25	53	45	54	43	46	.49	−.1	5	4,240	n.	23	s.	7	21	6	4	2.5	.0	.0
Boise	2,739	79	87	27.07	29.84	−.09	78.3	+5.4	104	16	94	54	12	63	39	60	48	41	.41	+.2	4	3,875	nw.	24	se.	30	18	8	5	3.3	.0	.0
Pocatello	4,477	60	68	25.48	29.87	−.05	76.6	+5.8	100	19	90	53	1	63	39	58	46	41	2.44	+1.7	13	6,279	se.	30	s.	15	10	14	7	4.7	.0	.0
Spokane	1,929	101	110	27.90	29.89	−.07	72.8	+3.8	103	20	88	49	26	58	43	55	40	38	.07	−.6	4	4,602	s.	22	sw.	7	23	4	4	2.3	.0	.0
Walla Walla	991	57	65	28.85	29.90	−.07	77.0	+3.0	104	20	90	55	26	64	39	58	44	35	.04	−.4	3	4,372	s.	18	w.	8	23	6	2	2.1	.0	.0
Yakima	1,076	58	67	28.78	29.90	------	74.6	+3.2	104	20	89	49	5	60	37	57	43	38	.38	+.1	4	5,383	nw.	21	nw.	25	23	3	5	2.2	.0	.0
North Pacific Coast Region							**64.0**	**+2.1**										**79**	**1.63**	**+0.3**										**4.1**		
North Head	211	11	56	29.84	30.06	−.02	59.9	+2.7	67	29	63	53	20	56	9	57	55	85	1.38	+.4	9	10,540	nw.	43	se.	4	12	12	7	4.6	.0	.0
Seattle	125	90	321	29.88	30.01	−.03	65.9	+2.8	84	19	75	54	16	57	27	57	51	64	.55	−.1	4	6,115	n.	26	sw.	4	16	10	5	3.7	.0	.0
Tatoosh Island	86	10	54	29.95	30.04	−.01	58.8	+3.7	68	1	63	51	15	55	13	56	54	86	2.74	+1.2	11	6,113	sw.	33	s.	3	14	8	9	5.0	.0	.0
Medford	1,329	29	58	28.55	29.93	------	71.0	------	99	20	87	48	25	56	42	58	50	56	.58	+.2	3	------	w.	----	----	----	25	3	3	----	.0	.0
Portland, Oreg	153	68	106	29.85	30.01	−.04	67.8	+1.1	88	19	78	53	25	58	29	59	54	65	.40	−.2	4	4,838	nw.	17	sw.	3	17	6	8	3.7	.0	.0
Roseburg	510	45	76	29.46	30.00	−.03	67.6	+.2	92	19	81	49	15	54	38	58	50	62	.51	+.2	5	3,905	n.	16	ne.	25	17	7	7	3.7	.0	.0
Middle Pacific Coast Region							**69.7**	**+2.4**										**61**	**0.14**	**+0.1**										**2.4**		
Eureka	62	73	89	29.96	30.03	−.02	58.0	+2.5	69	4	62	47	25	54	15	55	53	86	.09	.0	1	5,446	n.	24	n.	6	14	11	6	5.0	.0	.0
Redding	722	20	34	----	----	----	83.1	+1.3	110	19	96	58	9	70	34	62	46	34	.42	+.3	2	5,930	nw.	20	nw.	30	27	2	2	1.1	.0	.0
Sacramento	66	92	115	29.75	29.82	−.06	78.3	+5.1	109	19	95	55	27	62	42	61	49	45	T	.0	0	5,837	s.	19	sw.	2	27	3	1	1.0	.0	.0
San Francisco	155	112	132	29.72	29.89	−.06	59.4	+.9	73	18	66	50	27	53	19	54	51	80	.03	.0	1	8,047	w.	25	w.	2	18	12	1	2.7	.0	.0
South Pacific Coast Region							**76.5**	**+3.3**										**62**	**.00**	**.00**										**3.5**		
Fresno	327	97	105	29.47	29.81	−.02	84.8	+2.7	110	23	100	58	11	69	37	63	47	33	T	.0	0	5,300	nw.	24	n.	8	23	7	1	2.0	.0	.0
Los Angeles	338	159	191	29.51	29.87	−.03	74.1	+3.9	97	18	83	61	1	65	25	64	61	71	.01	.0	1	4,175	sw.	15	w.	17	19	8	4	3.6	.0	.0
San Diego	87	62	70	29.78	29.86	−.06	70.6	+3.4	84	20	75	61	1	66	13	65	63	81	.01	.0	1	4,871	sw.	17	nw.	21	11	14	6	4.9	.0	.0
West Indies																																
San Juan, P. R.	82	9	54	29.94	30.03	------	80.0	−.1	89	10	84	70	22	76	14	----	----	----	7.52	+1.6	18	10,223	e.	34	s.	22	5	19	7	5.6	.0	.0
Panama Canal																																
Balboa Heights	118	6	92	------	[3]29.82	.00	80.6	+.3	92	18	87	72	6	74	17	----	----	[3]85	5.94	−1.4	11	3,544	nw.	31	nw.	20	0	7	24	8.4	.0	.0
Cristobal	36	6	97	------	[3]29.83	−.01	81.6	+1.2	91	24	87	72	6	76	17	77	76	[3]84	18.72	+3.0	24	4,187	se.	24	nw.	19	0	4	27	8.8	.0	.0
Alaska																																
Fairbanks	455	11	87	[3]29.38	[3]29.88	------	60.5	------	86	3	71	39	13	50	36	54	48	69	.81	------	9	4,913	s.	23	sw.	4	6	8	17	6.9	.0	.0
Juneau	80	96	116	[3]29.84	[3]29.93	------	57.4	------	79	18	64	44	13	51	27	53	49	78	6.48	------	22	4,447	s.	20	se.	5	3	7	21	8.0	.0	.0
Hawaiian Islands																																
Honolulu	38	86	100	[3]29.98	[3]30.02	------	77.8	+.1	84	18	82	70	28	74	13	70	66	70	.82	−.4	24	7,605	e.	24	e.	30	9	21	1	4.8	.0	.0

[1] Observations taken at airport.
[3] Observations taken hourly.
[4] Pressure not reduced to mean of 24 hours.

TABLE 2.—*Data furnished by the Canadian Meteorological Service, July 1936*

Station	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max.+ mean min.÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*Inch*	*Inch*	*Inch*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*Inch*	*Inch*	*Inch*
Cape Race, Newfoundland	99				52.2		58.3	46.1	66	41	3.78		0.0
Sydney, Cape Breton Island	48	29.77	29.82	−0.11	62.6	+0.3	72.3	53.0	84	42	3.06	−0.59	.0
Halifax, Nova Scotia	88	29.59	29.69	−.27	62.8	−.6	70.3	55.4	77	49	2.49	−1.56	.0
Yarmouth, Nova Scotia	65	29.74	29.81	−.14	60.9	+1.4	69.2	52.7	82	46	1.90	−1.57	.0
Charlottetown, Prince Edward Island	38	29.73	29.77	−.13	63.8	−.3	71.5	56.2	79	50	4.23	+.74	.0
Chatham, New Brunswick	28	29.68	29.71	−.17	63.3	−1.7	73.7	52.8	84	44	3.19	−1.00	.0
Father Point, Quebec	20	29.74	29.76	−.09	56.6	−1.0	64.2	49.1	74	44	3.26	+.22	.0
Quebec, Quebec	296	29.47	29.78	−.13	65.2	−.3	73.7	56.6	84	47	4.29	+.03	.0
Doucet, Quebec	1,236				59.4		73.2	45.6	89	29	6.45		.0
Montreal, Quebec	187	29.65	29.85	−.08	68.3	−.2	76.5	60.1	88	50	4.71	+.42	.0
Ottawa, Ontario	236	29.60	29.86	−.08	67.2	−2.3	78.9	55.5	96	43	4.27	+.80	.0
Kingston, Ontario	285												
Toronto, Ontario	379	29.50	29.89	−.08	73.1	+5.1	84.1	62.2	105	52	.77	−2.15	.0
Cochrane, Ontario	930				63.9		75.7	52.1	95	41	1.60		.0
White River, Ontario	1,244	28.64	29.93	−.01	63.5	+4.0	80.8	46.3	100	32	.67	−2.13	.0
London, Ontario	808				70.0		85.1	54.9	102	38	.48		.0
Southampton, Ontario	656												
Parry Sound, Ontario	688												
Port Arthur, Ontario	644	29.33	30.03	+.09	64.5	+2.5	76.9	52.1	104	38	1.66	−1.82	.0
Winnipeg, Manitoba	760	29.07	29.88	−.05	75.5	+9.5	88.6	62.4	108	43	1.87	−1.21	.0
Minnedosa, Manitoba	1,690												
Le Pas, Manitoba	860				69.2		79.9	58.6	93	47	1.62		.0
Qu'Appelle, Saskatchewan	2,115	27.65	29.84	−.08	71.4	+7.9	85.4	57.4	101	41	1.79	−.69	.0
Moose Jaw, Saskatchewan	1,759												
Swift Current, Saskatchewan	2,392	27.35	29.78	−.13	75.0	+8.5	90.6	59.4	104	44	.64	−1.80	.0
Medicine Hat, Alberta	2,365												
Calgary, Alberta	3,540	26.29	29.88	−.02	67.2	+6.6	83.7	50.7	96	42	.13	−2.55	.0
Banff, Alberta	4,521												
Prince Albert, Saskatchewan	1,450												
Battleford, Saskatchewan	1,592	28.18	29.88	−.02	70.6	+5.9	85.8	55.3	99	47	.97	−1.37	.0
Edmonton, Alberta	2,150												
Kamloops, British Columbia	1,262	28.60	29.86	−.08	71.8	+3.3	86.9	56.8	101	46	.20	−1.41	.0
Victoria, British Columbia	230	29.76	30.01	−.04	60.5	+.5	67.7	53.2	74	51	.85	+.45	.0
Barkerville, British Columbia	4,180												
Estevan Point, British Columbia	20				58.5		64.9	52.1	68	45	8.40		.0
Prince Rupert, British Columbia	170				55.8		62.2	49.4	72	45	5.77		.0
St. George's, Bermuda	158		30.12	−.02	80.4	+1.9	85.3	75.4	90	68	1.80	−1.98	.0
LATE REPORTS JUNE 1936													
Father Point, Quebec	20	29.78	29.80	−0.07	54.3	+1.3	62.3	46.4	76	41	4.70	+1.72	.0
Quebec, Quebec	296	29.50	29.81	−.11	57.9	−3.3	73.0	42.8	87	40	2.72	−.93	.0
Doucet, Quebec	1,236				53.0		68.5	37.6	85	24	1.65		.0
Ottawa, Ontario	236	29.63	29.89	−.05	62.9	−2.4	74.8	51.2	86	39	2.02	−.90	.0
Kingston, Ontario	285	29.59	29.89	−.08	63.2	−.2	71.3	55.1	82	44	2.12	−.31	.0
Cochrane, Ontario	930				54.9		66.8	43.0	85	31	2.72		.0
White River, Ontario	1,244	28.62	29.93	−.01	52.5	−6.2	67.5	37.5	81	26	2.71	+.49	.0
Southampton, Ontario	656	29.23	29.94	−.03	57.3	−3.1	67.4	47.2	78	36	2.04	−.31	.0
Parry Sound, Ontario	688	29.22	29.90	−.06	61.1	−.6	70.8	51.4	84	40	3.12	+.70	.0
Port Arthur, Ontario	644	29.31	30.02	+.08	55.2	−1.2	68.2	41.2	84	31	1.78	−.95	.0
Minnedosa, Manitoba	1,690	28.13	29.92	+.03	59.3	−.3	70.4	48.1	91	35	2.06	−.94	.0
Moose Jaw, Saskatchewan	1,759				61.4		73.3	49.5	92	36	2.69		.0
Swift Current, Saskatchewan	2,392	27.37	29.85	−.02	61.5	+1.5	74.4	48.6	98	28	2.64	−.03	.0
Prince Albert, Saskatchewan	1,450	28.39	29.96	+.09	58.6	+.9	68.2	49.1	86	34	2.14	−.37	.0
Battleford, Saskatchewan	1,592	28.19	29.91	+.05	61.2	+1.7	73.6	48.8	98	30	2.20	−1.11	.0
Edmonton, Alberta	2,150	27.64	29.88	+.04	59.0	+2.1	69.9	48.2	92	30	1.91	−.95	.0
Victoria, British Columbia	230	29.71	29.96	−.05	58.3	+2.0	65.2	51.4	74	49	1.68	+.48	.0

TABLE 3—*Severe local storms, July 1936*

[Compiled by Mary O. Souder from reports submitted by Weather Bureau officials]

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Arkansas City, Ark	1				$500	Wind	Damage to outbuildings and garages.
Ironwood, Mich.[1]	1	4 p. m.		0	10,000	Tornado	Several barns wrecked, trees uprooted, and other property damaged.
Arbor Vitae and Minocqua, Wis.	1					Heavy hail	Much crop loss.
Lake Tomahawk, Wis., vicinity of.	1				2,300	do	Property damaged; loss to crops.
Oconto, Wis., vicinity of	1					Hail	Considerable loss to crops.
Oshkosh, Wis., and vicinity	1				3,500	Heavy hail	Loss to crops, $2,000; property damage, $1,500.
Belmont, La., vicinity of	2	4 a. m.		0	2,700	Tornado	Property damaged; loss to crops.
Mangham, Archibald, Darnell and Pioneer, La.	2	6:40–7:30 a. m.	25–100	2	52,000	do	28 persons injured; damage to buildings and timber; loss to crops.
Great Falls, Mont.[1]	2	8 p. m.				Wind	Chicken house, carried through the air for 25 feet, landed on a frame garage which was almost reduced to wreckage. Farmhouse untouched by the wind. Residents of this area described this storm as wind which rolled along the ground carrying with it billowing clouds of dust without any visible evidence of the funnel-shaped clouds.
Canton, N. Y., vicinity of	3	A. m.			1,000	Thunderstorm	Barn destroyed.
Sanford, Tenn	3	1 p. m.		0	2,000	Tornado	Property damaged.
Calhoun and Charleston, Tenn	3	2 p. m.		0	13,000	do	6 persons injured; property damaged.
Walden, Ga	3	9 p. m.	880	0	200	do	Trees uprooted, houses unroofed and other buildings damaged. A woman was hurled across a room while trying to hold the door shut; boy injured by flying timber. $200 damage to buildings. Loss to pecan orchards not estimated.
St. Lawrence County, N. Y., nothern portion.	3					Thunderstorm	Basements and cellars flooded causing much damage; 2 barns destroyed.
Youngstown, N. Y. vicinity of	3				2,000	Heavy hail	Loss of fruit.
Anne Arundel County, Md., southern portion.	4	5–5:10 p. m.				do	500 acres of tobacco and 1,000 acres of corn and other crops destroyed over an area of 6 square miles.
Spartanburg County, S. C.	5	3 p. m.	880		1,000	Hail	Loss of crops.
Wythe, Smyth and Washington Counties, Va.	6	2:30 a. m.	[2] 1–20		18,100	Thunderstorm and hail.	Crops loss $12,500; damage to buildings $5,600.
Yakima-Moxee district, Wash.	7				25,000	Cloudburst	Roads, bridges and irrigation flumes from washouts damaged; loss to crops due to holding up irrigation at a critical time.
Cairo, Ill., vicinity of	7–8	P. m.				Thunderstorm	2 barns burned with considerable loss of hay and livestock.
Indianapolis, Ind	8	5:17 – 6:27 p. m.		2		Thundersquall and heavy rain.	Rain very heavy in the northern section of the city, and with high winds, caused much damage to buildings and trees. 2 persons killed by lightning.
Valley Falls, Fairforest, Woodruff, and Hayne, S. C.	8	P. m.			60,000	Hail	Crop loss in these vicinities, $30,000; in Hayne section loss in commercial peach crop, $30,000.
Newton, Ill.	8				10,000	Electrical and wind.	Several barns and residences struck by lightning; property damage by wind, $10,000.
Columbus, Miss., and vicinity	8				30,000	Thundersquall	Property damaged.
Devils Lake, N. Dak	8					Wind, rain, and hail.	A few miles from the city wind reached tornadic proportions, doing considerable damage.
Presidio, Tex	9	5:30 p. m.	200		800	Wind	Property damaged.
Dayton, Ohio, and vicinity	9	10 – 10:30 p. m			3,000	Thundersquall	Light hail fell at Northridge breaking windows; radio station at Dayton struck by lightning; 4 miles west of Camden, barn and contents destroyed.
Sealy, Tex	10	3 p. m.	880		2,000	Wind	No details.
Franklin and Pittsylvania Counties, Va.	10	6 p. m.	[2] 2		21,000	Wind, rain, and hail.	Loss to crops, $13,000; property damaged, $8,000.
Baltimore County, Md.	10	9 p. m.	500			Thundersqualls	Barns and other small farm buildings demolished; trees uprooted; path 500 yards long.
Orleans and Monroe Counties, N. Y.	10					Wind	Several thousand dollars' damage to buildings and telephone and power lines; loss to fruit crop.
McNeill, W. Va	10					Hail	Considerable damage to crops.
Tomahawk, Wis.	11		440	0	5,000	Tornado	Funnel-shaped cloud reported. Large barn destroyed; other property damaged.
Denver, Pa.	12	4–4:15 p.m.				Wind and hail	Much loss to crops, trees uprooted, and small buildings damaged.
Highmore, S. Dak., vicinity of	12	4:30 p. m.	67	0	300	Tornado	Windmill, chicken house, and granary wrecked.
Charles County, Md.	12	5 p. m.			100,000	Heavy hail	Crops destroyed, property damaged, and livestock injured over an area of 50 square miles.
Pukwana, S. Dak.	12	5:45 p. m.	100		2,650	Wind	Garage, shed, and small airplane hangar destroyed; several windows broken.
Philadelphia and Syracuse, S. C.	13	4 p. m.			5,000	Hail	Loss to crops over a path several yards wide.
Amorel and Barfield, Ark., and vicinity.	13				500	Wind	Damage to buildings.
Camden, S. C., and vicinity	13		[2] 2		22,000	Thunderstorm and hail.	Loss to crops from hail, $20,000; property damage, $2,000.
Richland, Newberry, and Lexington Counties, S. C.	13				5,600	Electrical	Property damaged.
Harrisburg, Pa., and vicinity	14	P. m.			92,000	Wind and heavy rain.	In Hummeltown where 18 buildings were damaged, streets were covered with fallen trees, poles, etc. In a factory where a large portion of the roof was torn away, heavy rain poured through the work rooms and a 60-foot stack fell across 1 wing of the building causing loss to this firm of $75,000. 2 barns destroyed causing $17,000 loss. Full amount of damage not estimated.
Clinton, Ill., north of	14				2,000	Wind	Telephone lines down.
Ionia and Montcalm Counties, Mich.	14				25,000	do	Property damaged.
Tupelo, Miss.	14				5,000	Thundersquall	Do.
Dearborn County, Ind., central portion.	15	3–4 p. m.	[2] 1		50,000	Wind and hail	Loss to crops; damage to farm buildings; path 20 miles long.
Bentonville, Ark., vicinity of	15	3:20 p.m.		0	2,000	Tornado	Barns and brooder houses wrecked; path narrow.
Nashville, Tenn.	15	7:35 p. m.				Thundersquall, electrical.	Worst electrical storm in this vicinity in many years. Dozens of expensive transformers destroyed, poles blown down, man injured by lightning, and number of fires reported.
Dawson and Monticello, Ill., and vicinity.	15				9,000	Wind	Corn badly blown, trees uprooted, and property damaged.
Monticello, Ill.	15		[2] 4–6		22,500	Hail	Loss to crops, $17,500; damage to property and loss to poultry, $5,000.
Macon, Ga.	15–16			1	105,000	Thundersquall and heavy rain.	4.70 inches of precipitation fell during this storm; more than 900 trees blown down. Much damage sustained by the Southern Bell Telephone Company and the Georgia Power Company.
Springfield, Mo.	16	P. m.				Thundersquall and hail.	Trees uprooted; power lines struck by lightning disrupting service for several hours.
Spring Hill, S. C.	16	do	880		4,000	Hail	Loss to crops; path 5 miles long.

See footnotes at end of table.

TABLE 3.—*Severe local storms, July 1936*—Continued

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Du Quoin, Pinckneyville and Marion, Ill.	16				$46,000	Thundersquall	In Du Quoin property damage was $40,000 and crop loss $3,000; in Marion loss to crops, $3,000.
San Jose, McLean, and New Holland, Ill.	16				53,500	Wind	Crop loss $50,000; damage to property $3,500.
Waterloo, Ill., vicinity of	16					Hail	Considerable damage to corn and other crops.
Cheyenne, Okla., vicinity of	17	3-4 p. m.	[1] 6		108,300	do	Loss to crops $108,000; to poultry $300; path 18 miles long.
Jerome, Ariz.	17					do	Loss to crops.
Subiaco, Ark., vicinity of	18	5:45 p. m.	100	0	7,000	Tornado	Damage to buildings $6,000; loss to crops $1,000.
Cotton Plant, Ark., and vicinity.	18				1,500	Wind	Damage to buildings.
Trenton, N. J., and vicinity	18	3:01 – 4:10 p. m.			5,000	Thunderstorm and hail.	Windows broken and greenhouses demolished by hail; large tree stripped of its foliage; barn destroyed by lightning; crops blown down.
Baraboo-Reedsburg, Wis.	18		[1] 2½		50,000	Wind and hail	Several barns destroyed; silos and telephone poles blown down; trees uprooted. Property damage $20,000; loss to crops $30,000.
Beadle, Deuel, Faulk, Kingsbury, McCook, and Moody Counties, S. Dak.	19	2-9 p. m.				Wind	Buildings and silos wrecked, machinery damaged, and trees uprooted. Loss in trucking.
Plains, Kans.	19	2:30 p. m.	[1] 1		700	do	Farm buildings damaged; path 5 miles long.
Omaha, Nebr.	19	6:30 p. m.			25,000	Wind, dust, and rain.	Maximum wind velocity of 73 miles per hour recorded, and accompanied by clouds of dense shifting dust which reduced visibility to zero from 10 to 15 minutes. Trees uprooted, power and telephone lines and poles blown down; windows broken and many roofs damaged and some blown off.
St. Joseph, Mo.	19	8:33 p. m.				Wind and dust	Much dust carried by the wind; some damage to trees, wires and buildings.
Cantrall, Ill.	19		440			Hail	Severe damage over small area to buildings; loss to crops and stock.
Carlinville, Ill., vicinity of	19				2,000	Electrical	Barn and contents burned.
Little Sioux, Morgan, Magnolia, Taylor, and St. Johns, Iowa.	19		[1] 6		55,000	Wind	$40,000 damage to buildings and $15,000 crop loss. In St. Johns the grandstand and other buildings at the fairgrounds were wrecked.
Moline, Kans., vicinity of	20	2:30 p. m.	[1] 2		5,000	Heavy hail and wind.	Windows broken and automobiles damaged; loss to crops; path 7 miles long.
Antlers, Okla.	20	5 p. m.	[1] 1		500	Wind	Property damaged; path 8 miles long.
Pontotoc and Johnston Counties, Okla.	20	6:30-7:30 p. m.	[1] 1½		12,900	Heavy hail	Loss to crops.
Cherokee, Kans., north of	20	P. m.			1,000	Heavy hail and wind.	Chief loss to corn crop; path narrow and short.
Alicia and Wiseman, Ark., and vicinity.	20				10,800	Wind	Loss to crops; property damaged.
Hanson, Ky.	20				10,000	do	Property damaged.
Clarksdale, Miss., vicinity of	20				15,000	Thundersquall	Damage to property.
Mount Pleasant, Ark.	20				2,000	Heavy rain	
Pontiac, S. C.	20				650	Electrical	Barn destroyed and a mule and cow killed.
Lamar, Grayson, Cooke, Dallas, Tarrant, Ellis, and adjacent Counties, Tex.	20–21	7 p. m.–12:02 a. m.			1,033,000	Wind	Highest wind velocity at Dallas since the establishment of the station, 68 miles recorded at 11:52 p. m., on the 20th, with $1,000,000 property damage. Several persons injured.
Little Rock, Ark.	20–21				7,000	Electrical	Cotton gin burned; church steeple and power equipment damaged.
Edgecombe, Pitt, and Martin counties, N. C.[1]	21	3-3:15 p. m.				Heavy rain, electrical, wind, and hail.	Number of farmers said to have been virtually ruined when the unprecedented downpour of rain and hail stripped their cotton stalks and laid tobacco plants flat in a sea of mud. In addition to crop loss much damage to buildings, trees, power, and telephone equipment.
Fountain Inn, S. C.	21	4 p. m.	[1] 2		32,000	Thunderstorm and hail.	Loss to peaches and other crops by hail, $30,000; several houses unroofed.
Pauls Valley, Okla., and vicinity.	21	8 p. m.			3,000	Wind	Loss to crops; property damage.
Sweetwater, Tex.	21	10 p. m.	[1] 4			do	No details.
Rosedale, Okla.	21	P. m.	[1] 7		15,000	do	Several buildings blown down, others unroofed; crops especially broomcorn beaten to the ground; many trees blown down; path 15 miles long.
Highway 10, Perry-Pulaski County line, Ark.	21				10,000	Hail	Loss to crops; property damaged.
Jonesboro, Ark., 8 miles south of.	21				20,000	Wind and hail	No details.
Little Rock, Ark.	21				50,000	Heavy rain	Damage to gravel streets.
Rudd to Pleasant Grove, Iowa.	22	P. m.	[1] 2–5		30,000	2 thundersqualls and hail.	First storm accompanied by hail with little wind; most severe hail in Rudd, with damage to corn crop over a path 2 miles wide; in some places hail fell to the depth of 2 inches. Second storm was one of severe wind with some hail; damage to buildings on about 50 farms and many shade and fruit trees blown down. Damage from this storm $30,000, over a path 5 miles wide.
Orange, Iowa	22				18,000	Wind	Property damaged.
Union, Iowa, vicinity of	22				1,300	do	Damage to property.
Platteville, Wis., vicinity of [1]	23	A. m.			3,000	Electrical	Barn and contents destroyed.
Fruitville, Fla., vicinity of	23	4:30–6 p. m.	[1] 1		600	Thundersquall and hail.	Considerable damage to crops and celery plant beds.
Hendricks and Morgan Counties, Ind.	23	8-9 p. m.	[1] 4		400,000	Wind and hail	Damage over a path 10 miles long.
Cleveland, Ohio	23	P. m.			2,000	Thundersquall and heavy rain.	Street-car conductor injured by lightning; property damaged.
Fort Wayne, Ind.	23				10,000	Thunderstorm	Telephone and power lines damaged.
Trenton, N. J.	23–24	P. m.		2	20,000	Thundersquall	Many injured when a large tent with 50 persons in it was lifted by the wind and carried 100 feet.
Helena, Mont.	24	do			3,500	do	0.22 inch of rain in 4 minutes, accompanied by wind; property damaged.
Salome, Ariz.	24					Wind and hail	Much crop loss; trees and buildings damaged.
Salt Lake Valley, Ariz.	24			1	7,000	Wind and rain	18-inch wall of water swept off Camelback Mountain over the desert flats. Sunnyslope reported much flood damage with some houses being carried off their foundations.
Escanaba, Mich., and vicinity.	25	P. m.				Thunderstorm and heavy hail.	Considerable damage occurred. Automobile tops ruined; windows broken; chickens killed and loss to gardens.
New York State, northern section.[1]	25	do		0		Tornado and heavy rain.	Much damage to farm property. Loads of hay and farming implements picked up and carried away; tin roof of barn partially torn off and 2 farmers injured; many trees felled.
Arizona, central and southern portions.	25				21,000	Heavy rain and wind.	Railroad tracks and bridge washed out, underpasses flooded, and highway traffic disrupted. Casa Grande and Gilbert flooded, with water entering stores. Phoenix, Mesa, and other towns had water standing in streets, sewers being unable to take care of the downpour. Irrigation canals in Salt River Valley broke their banks, flooding several hundred acres of farm lands, ruining crops, and killing small animals. Wind caused much damage to buildings and trees.
Buckhart, Ill.	25					Hail	Considerable loss to crops.
Faulkston, S. Dak., vicinity of	25	7:30 p. m.				Wind	Number of buildings wrecked; telephone poles and trees blown down.
Shipton to New Cambria, Kans., vicinity of.	27	5–5:30 p. m.		0	15,000	Tornado and hail.	Small damage from hail occurred in part of stricken area near Bemington, but path not well-defined. Barns, other farm buildings and a residence badly damaged. Path 16 miles long.

See footnotes at end of table.

TABLE 3.—*Severe local storms, July 1936.*—Continued

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Morrowville to Bremen, Kans.	27	5:15 p. m.	[2] 2	0	$4,000	Tornado	Large number of farm buildings damaged or totally destroyed. Path 20 miles long and not well-defined.
Detroit, Kans., 6 miles north	27			0	75,000	do	Barns and other farm buildings demolished; telephone wires down; path not well-defined and 4 miles long.
Shannon, Kans., vicinity of	27	6:15 p. m.	880		1,000	Wind and hail	Number of farm buildings damaged or demolished, windows and roofs damaged by hail; path 2 miles long.
Fayette and Washington Counties, Pa.	27	P. m.		1	50,000	Tornado	One of the most severe storms in years with greatest damage in the vicinity of Brownsville and Uniontown. 2 funnel-shaped clouds observed over Claysville about 4 p. m.
Toledo, Ohio, vicinity of	27	do		1		Thunderstorm	Several houses damaged and a boy injured by lightning.
Cumberland, Md	27				15,000	Thundersquall	Property damaged.
Grantsville, Md	27				10,000	do	Man injured and 6 cows killed when a large barn was blown over; 2 cows killed when an uprooted tree fell on them; 6 silos damaged or blown down.
Gratiot County, Mich	27				20,000	Electrical	Several barns destroyed.
Martinsburg, W. Va., and vicinity.	28					Hail	Loss mostly to crops.
Florida Peninsula	28–31				150,000	Tropical disturbance.	On the afternoon of the 28th the center of the storm was 75 miles southeast of Miami. It crossed the extreme southern tip of Florida, passing into the Gulf south of Everglade City with wind estimated at 55 miles per hour. After reaching the Gulf, the storm moved in a general northwestward direction. In the Boca Grande section the wind was estimated at 60 miles per hour with little damage reported. On the 31st, winds were 60 to 70 miles per hour on the coast in the vicinity of Camp Walton. Property damage in south Florida was very small. In the Camp Walton-Valparaiso area damage was estimated at $100,000; Panama City area $5,000; Apalachicola and vicinity $8,000; Pensacola area negligible. Damage to highways $10,000 to $15,000; telephone and telegraph companies $10,000. Pears and pecans blown from trees; crop loss not estimated, probable total damage $150,000.
Emporia, Va	29	5:30 p. m.	[2] 2½		20,000	Thundersquall and hail.	Damage to buildings $15,000; loss to crops $5,000.
South Chicago Lighthouse, Ill., vicinity of.[1]	29			14		Squall	Sand barge sunk and 14 members of the crew drowned in Lake Michigan.
Christian County, Ky., southern portion.	29					Wind and heavy rain.	Loss to crops; farm buildings damaged.
Jacksonville, Fla	30	5:30 p. m.			7,500	Thunderstorm	City electric plant damaged.

LATE REPORTS FOR JUNE 1936

Wahoo, Nebr.	1	5 p. m.	[2] 4–5		4,000	Hail	Damage to windows and roofs.
Broken Bow, Nebr.	2	4 p. m.	[2] 2–4		20,000	do	A considerable area of small grain and alfalfa destroyed.
Aurora, Nebr.	2	7 p. m.	[2] 2		30,000	do	Damage mostly to small grain.
Hutchinson and Hansford Counties, Tex.	3	do	[2] 4		250,000	Heavy hail	Much damage reported.
Hansford County, Tex.	4	6 p. m.	[2] 15		322,000	Wind and hail	Crop loss, $320,000; property damage, $2,000.
Wichita Falls, Tex.	6	5:20 p. m.	440	0	50,000	Tornado	Injury to 2 persons. No other details.
Morrill and Garden Counties, Nebr.	8	7:15 p. m.	[2] 3		50,000	Hail	Damage over a path 45 miles long.
Aurora, Nebr.	9	6 a. m.	[2] 1		30,000	do	Property damaged.
Buffalo and Dawson Counties, Nebr.	9	3:30–5:30 a.	[2] 2–5		200,000	do	Damage over a path about 60 miles long.
Columbus, Nebr.	9	6:30 a. m.	[2] 1		10,000	do	Property damaged.
Paducah, Tex.	22	P. m.	[2] 7		70,000	Wind	1 person injured. No other details.
Tomball, Tex.	23	10:30 a. m.	[2] 3		2,000	do	No details.
Nelson, Nebr.	29	7 p. m.	100	0	2,000	Tornado	Property damaged. No details reported.
Yellow Medicine and Redwood Counties, Minn.	30	3–4 p. m.	[2] 9		50,000	Hail	Loss to crops, livestock, and poultry; property damaged; path 5 miles long.

[1] From press reports.
[2] Miles instead of yards.

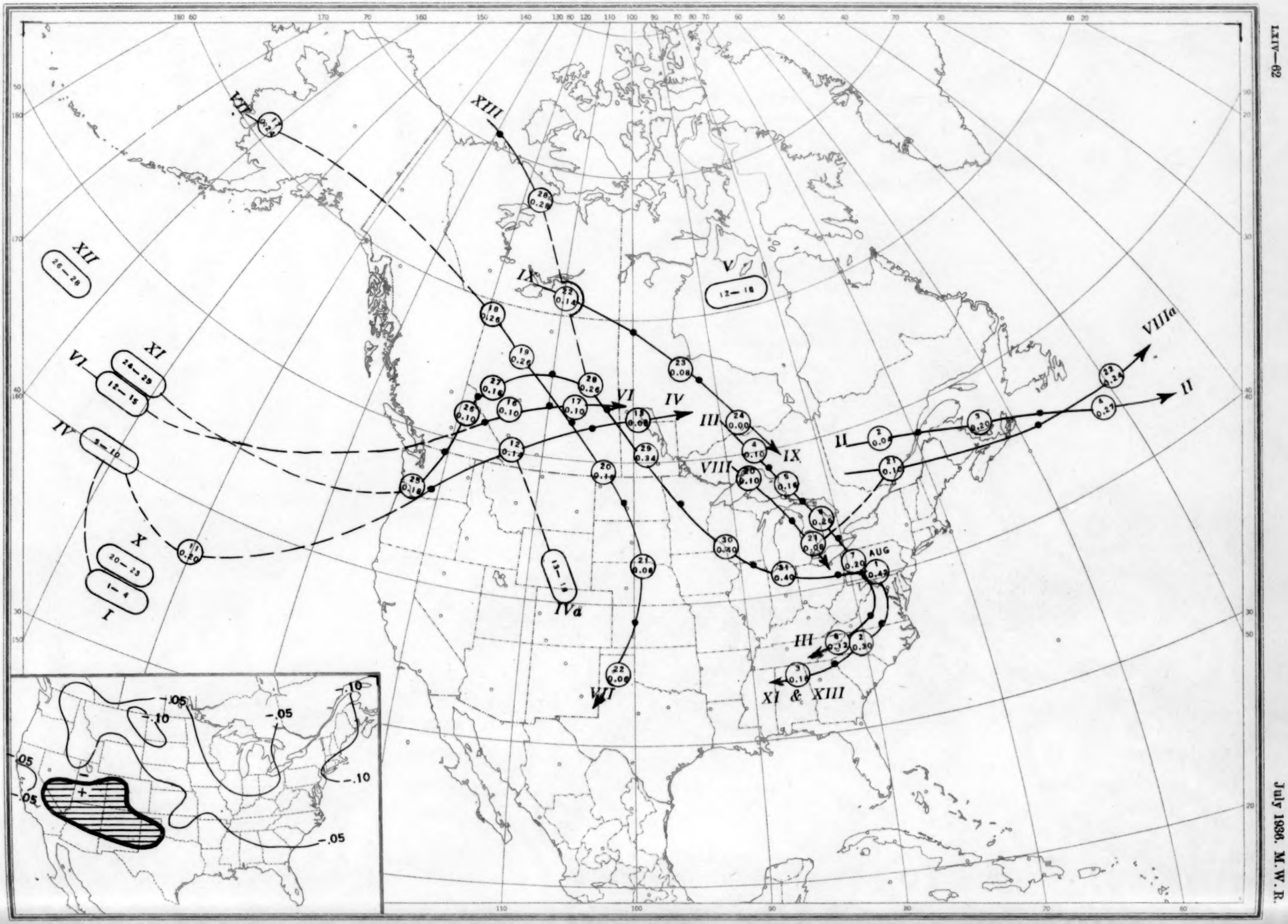
Chart I. Departure (°F.) of the Mean Temperature from the Normal, July 1938

Chart I. Departure (°F.) of the Mean Temperature from the Normal, July 1936

Shaded portions show excess (+)
Unshaded portions show deficiency (−)
Lines show amount of excess or deficiency
Statute Miles
Kilometers

Chart II. Tracks of Centers of Anticyclones, July 1936. (Inset) **Departure of Monthly Mean Pressure from Normal**

(Plotted by W. P. Day)



Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

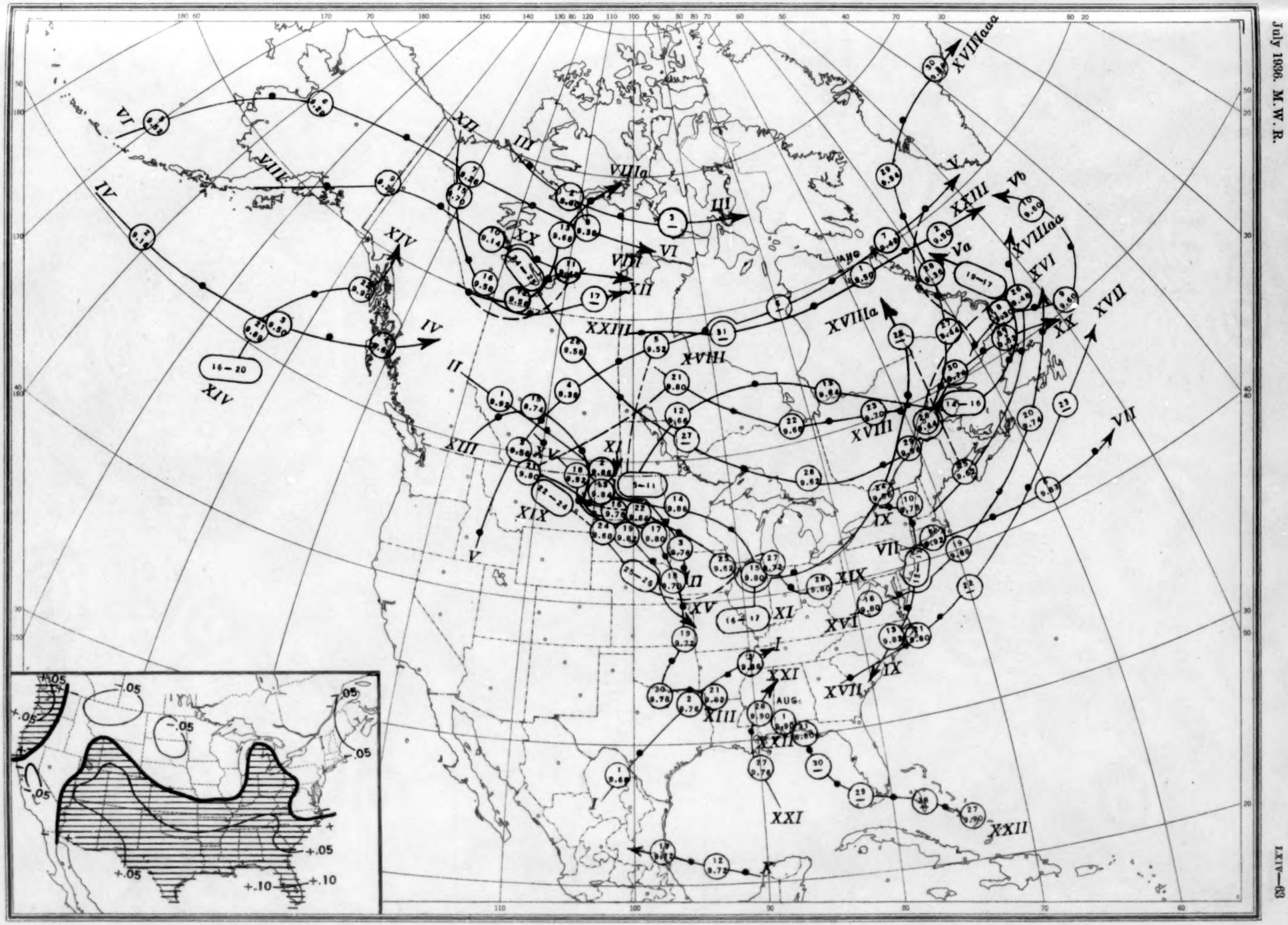
Chart III. Tracks of Centers of Cyclones, July 1936. (Inset) **Change in Mean Pressure from Preceding Month**

(Plotted by W. P. Day)

Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, July 1936. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by W. P. Day)



Circle indicates position of cyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 8 p. m. (75th meridian time).

Chart IV. Percentage of Clear Sky Between Sunrise and Sunset, July 1936

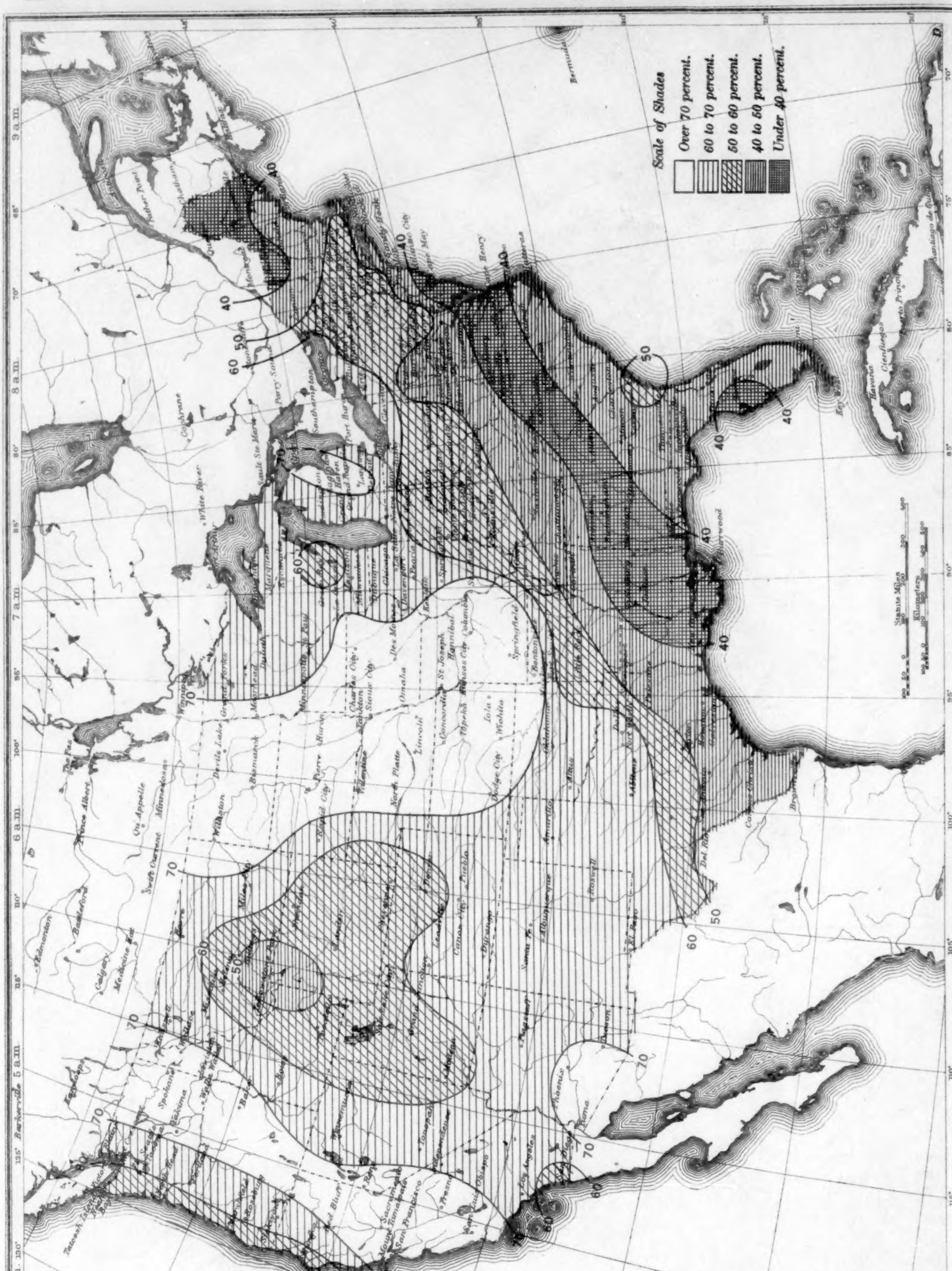


Chart V. Total Precipitation, Inches, July 1936. (Inset) Departure of Precipitation from Normal

Chart V. Total Precipitation, Inches, July 1936. (Inset) Departure of Precipitation from Normal

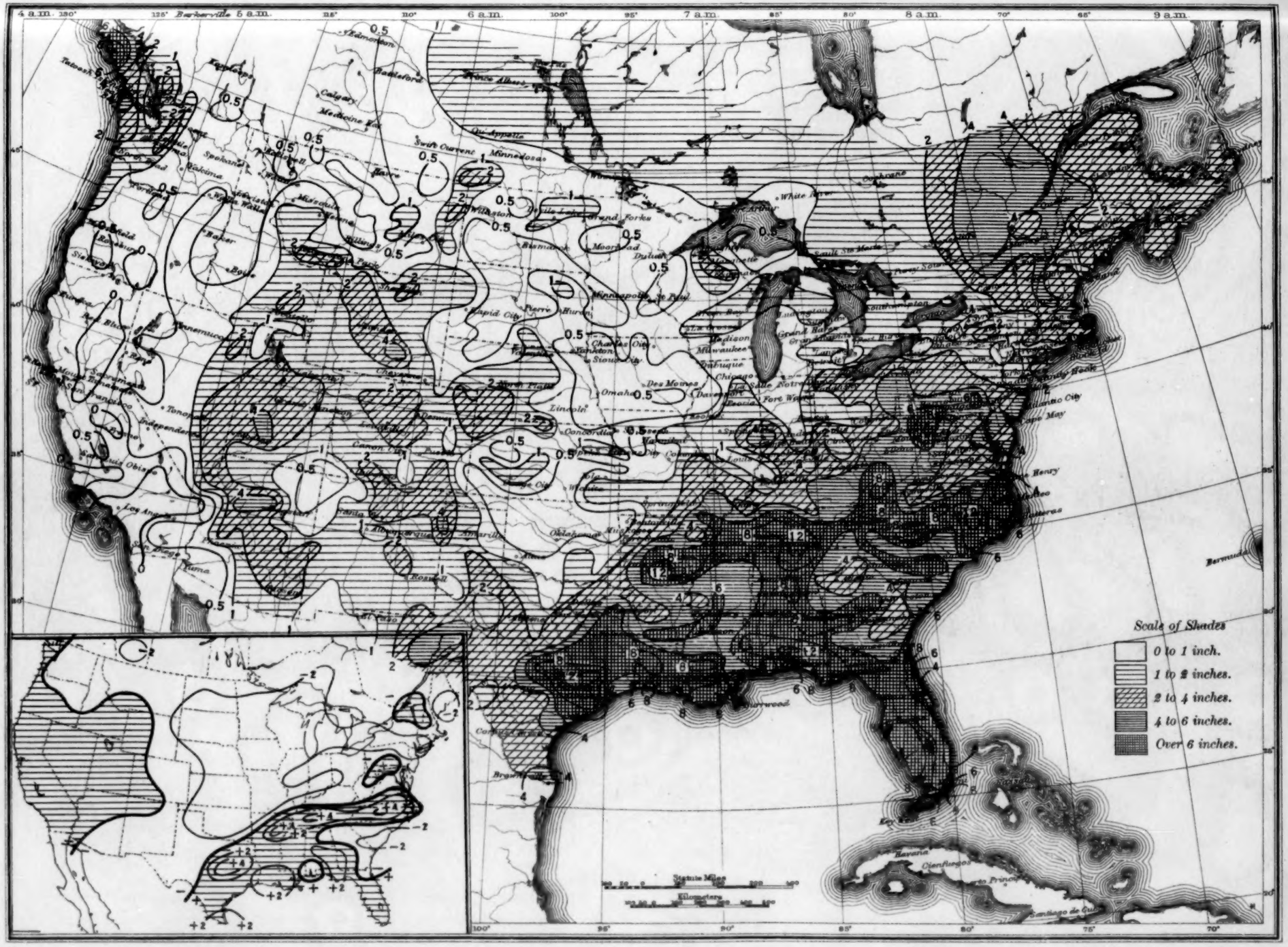


Chart VI. Isobars at Sea Level and Isotherms at Surface; Prevailing Winds, July 1936

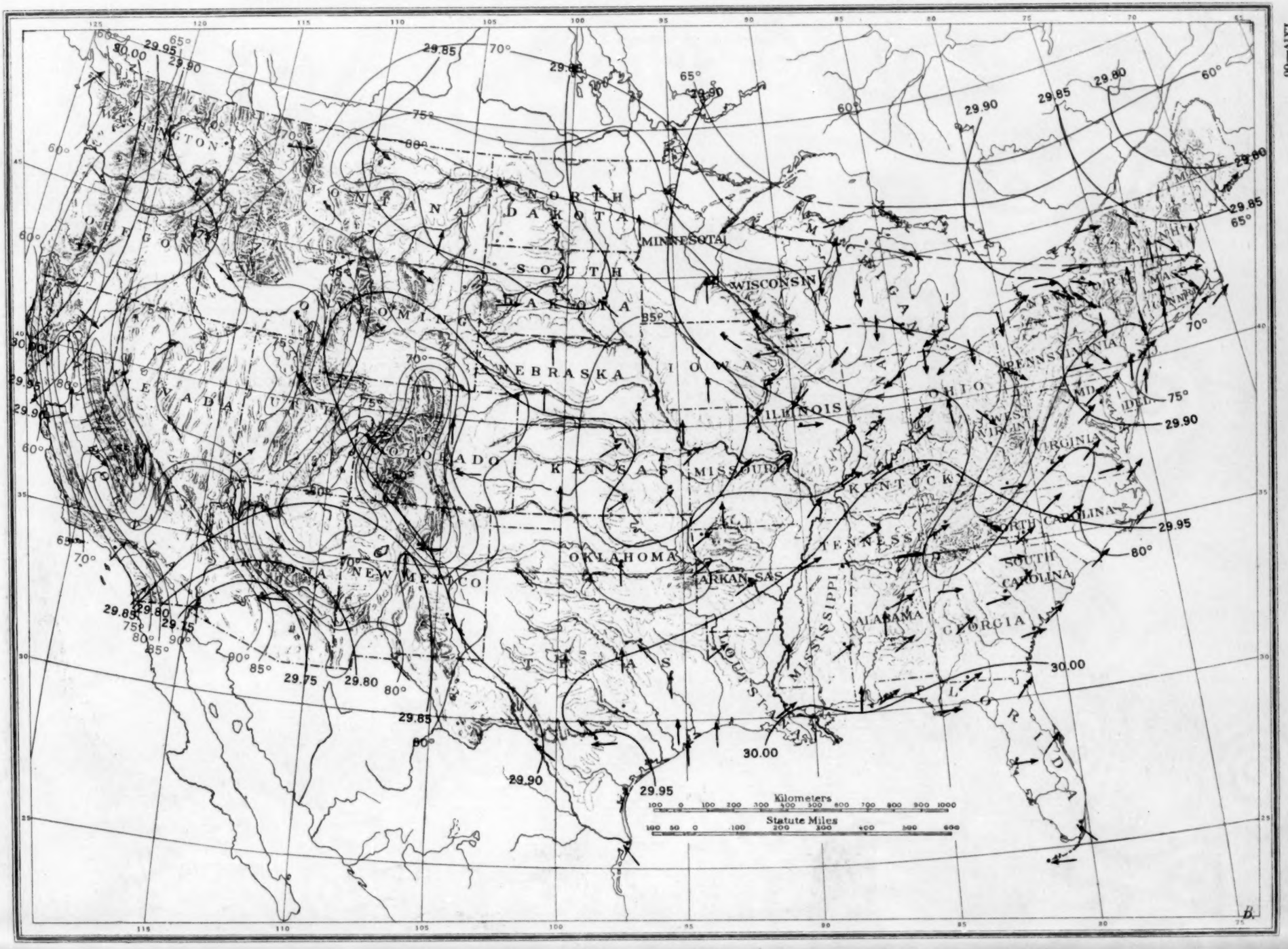


Chart VII. Wind Roses for Selected Stations, July 1936

(Plotted by W. W. Reed)

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(Plotted by W. W. Reed)

UNIV. OF MICH.

Chart IX. Weather Map of North Atlantic Ocean, July 27, 1936
(Plotted from the Weather Bureau Northern Hemisphere Chart)

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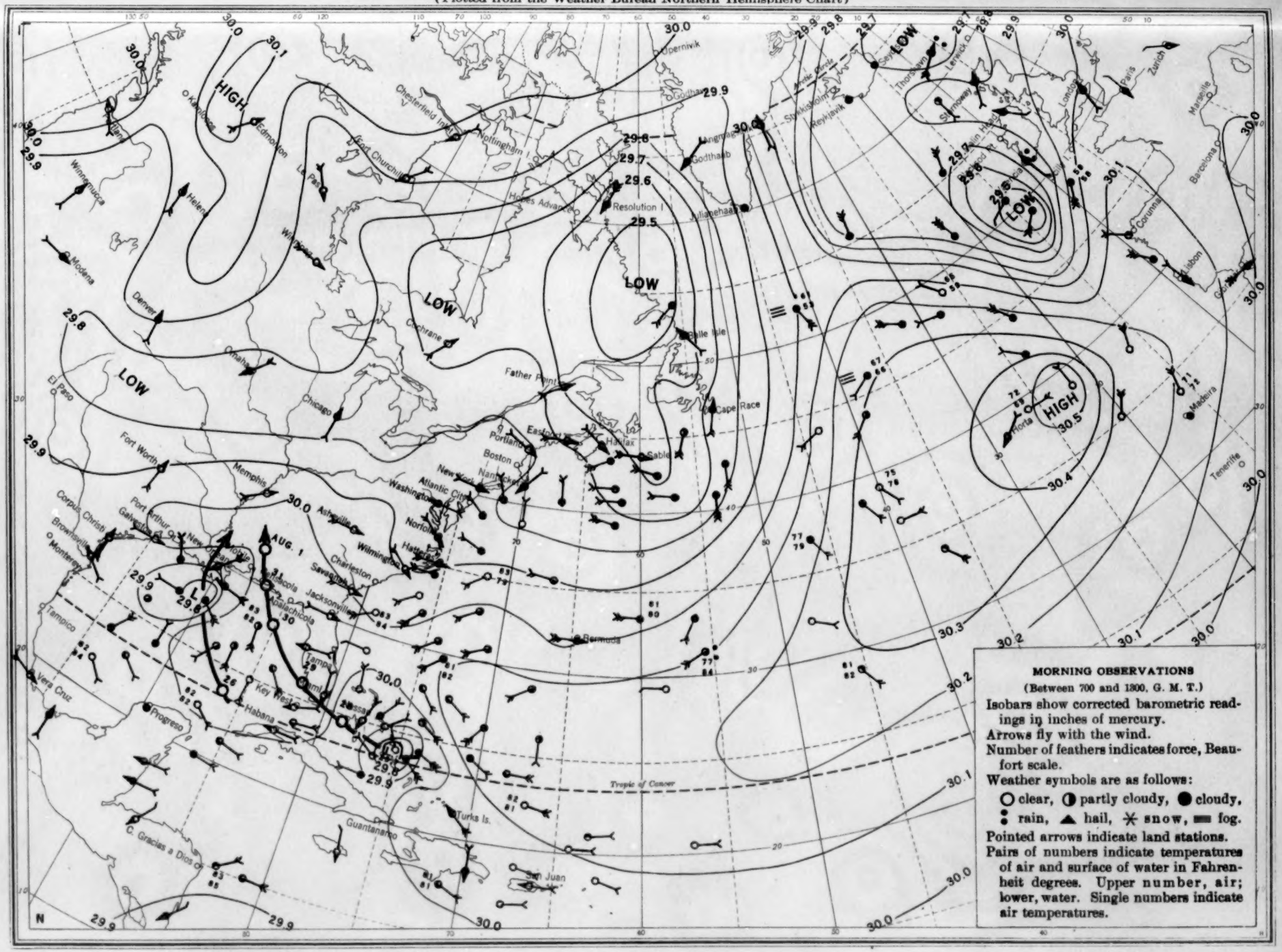
(Plotted from the Weather Bureau Northern Hemisphere Chart)



MORNING OBSERVATIONS

(Between 700 and 1300, G. M. T.)

Isobars show corrected barometric readings in inches of mercury.

Arrows fly with the wind.

Number of feathers indicates force, Beaufort scale.

Weather symbols are as follows:

○ clear, ◑ partly cloudy, ● cloudy,
⁝ rain, ▲ hail, ✳ snow, ▬ fog.

Pointed arrows indicate land stations.

Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water. Single numbers indicate air temperatures.